CHART II Business Area Architecture Report

**Contract DBM-9713-NMS
TSR # 9901961
Document # M361-BA-005R0**

**August 23, 2000
By
Computer Sciences Corporation and PB Farradyne, Inc.**

Revision	Description	Pages Affected	Date
0	Initial Release	All	August 23, 2000

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1 Executive Summary

1.1 Overview

The CHART II project began in Hanover, Maryland on November 30, 1998, after a successful design competition. In the design competition, CSC/PBFI was provided with application requirements and responded with a proposed system design and prototype software by which a determination was made and the contract awarded to CSC/PBFI. As part of the design competition, the use of CSC's Catalyst methodology was proposed. The first phase of utilizing this methodology is the analysis and preparation of this Business Area Architecture Report.

As a result of Catalyst training and the Initiation and Visioning Workshops, it became apparent that the requirements on which the design competition was based inadequately reflected the future business objectives of the CHART II system as a system to support State-wide operations, other SHA agencies, and CHART/SHA partners well into the future. Once this was understood and the project's Principles, Constraints and Assumptions were developed to address these business needs, work proceeded into business process design and development of the business and system architecture.

This BAA Report focuses primarily on the needs of SHA and the Traffic Operations Centers for an operational system to manage traffic on state highways, and is not intended to address the entire vision of CHART as a multi-modal Integrated Transportation System. The approach to initially concentrate on the operational traffic management aspects of CHART was taken to address the immediate concerns for a traffic management system to replace the defective existing system. This approach was also taken to establish a business and technical baseline on which to conduct further visioning and business analysis. From here, it would expand into the full statewide multi-modal Integrated Transportation System in the future.

The first section of this report is the Executive Summary. Within the Executive Summary, the project background is reviewed; the case for action is clarified; the vision is reviewed, and the future Chart II System (broken down by the Six Domains of Change) is summarized.

1.2 Background

CHART (Coordinated Highways Action Response Team) is a joint effort of the Maryland Department of Transportation and the Maryland State Police, in cooperation with other federal, state and local agencies. CHART's mission is to improve "real-time" operations of Maryland's highway system through teamwork and technology. The CHART program relies on communication, coordination, and cooperation among agencies and disciplines, both within Maryland and with neighboring states, to foster the teamwork necessary to achieve our goal. This is consistent with Maryland's State Highway Administration's overall mission, which is to provide Maryland with an effective and efficient highway system.

The CHART program is Maryland's entry into the ITS (Intelligent Transportation System) arena, and started in the mid-1980s as the "Reach the Beach" initiative, focused on improving travel to and from Maryland's eastern shore. It has become so successful that it is now a multi-jurisdictional and multi-disciplinary program, and its activities have extended not just to the busy Baltimore-Washington Corridor, but into a statewide program. The program is directed by the CHART Board, consisting of senior technical and operational personnel from SHA, Maryland

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Transportation Authority, (MdTA), Maryland State Police (MSP), Federal Highway Administration, the University of Maryland Center for Advanced Transportation Technology, and various local governments. The board is chaired by the Chief Engineer of the SHA. This comprehensive, advanced traffic management system is enhanced by a newly constructed state-of-the-art command and control center called the Statewide Operations Center (SOC). The SOC is the "hub" of the CHART system, functioning 24-hours-a-day, seven days a week, with satellite Traffic Operations Centers (TOCs) spread across the state to handle peak-period traffic.

1.3 Case for Action

The current CHART SOC represents the culmination of a four year systems development effort that was intended to provide statewide control of variable message signs (VMS), traveler advisory radio (TAR), and closed circuit television (CCTV) field equipment. The SOC was also to have offered the capability of receiving, processing and storing detector data and controlling various displays at the SOC and at remote workstations. Based on operating experience to date, the MD State Highway Administration has determined that a complete life-cycle based review and system design is needed to develop an integrated CHART Automated Transportation Management System (ATMS) that is more responsive to the State's needs.

The difficulties associated with the development of the current system appear to have been the result of the following problems:

- Inadequate definition of system requirements.
- A desire to use existing software that could not meet the system objectives.
- The evolution of system requirements to the point at which the system objectives exceeded the ability of the initial system to satisfy the rapidly evolving requirements and technological advances.
- Inadequate staff experience to permit the definition of system requirements.
- Perhaps most important, inadequate communications between the system developers and the staff regarding the systems capabilities.

In selecting the CSC/PBFI team, the SHA made a commitment to follow the Catalyst methodology in anticipation that this process would better identify the long range business goals of CHART and its partners, and factor these goals into the overall system design. These long-range business goals include additional functionality and utilization of advanced traffic sensor and control technology as advances in these areas progresses and availability of funding permits.

Catalyst training sessions provided opportunities to gather additional information from the CHART management and operations staff as to problems with the current system that should be avoided in the future system. These problems included both application/system problems and procedural problems, and are summarized in the following list:

1.3.1 System Problems

- Doesn't monitor and alert the operator when a system/component problem is detected

- Requires duplicate data entry

- Not module based

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- Devices do not allow for status checks

- Detection subsystem failing

- System not stable — fails frequently

- System not expandable

- No easy access to historical data

- Y2K compliance questionable

- No disaster recovery capability

1.3.2 Business Problems

- (Travelers) never trust the message displayed on a variable message sign

- Many informal agreements with partners/agencies

- Changing political priorities

- Too many subjective operator decisions

- No single point of contact for operations decisions

- Limited number of response personnel

- No single point of control over participating agencies

- No clear measures of performance

- Inadequate facilities

1.4 Vision of the Future CHART II System

The justification for Intelligent Transportation Systems is one of managing a national resource, that resource being our highways and interstates. Concurrent with this justification is the concept that better management of our highways (*i.e.,* the flow of traffic on those highways) leads to traveler cost and time savings through less travel time, fewer accidents, and reduced impact to the environment caused by emissions from slow or standing vehicles.

The long range vision for ITS is to eventually have technology-equipped vehicles that can select the most efficient path from trip origin to destination based on computer supplied information identifying highways with the least congestion or best traffic flow — on a nation-wide basis. Unfortunately, this is a long-range vision not yet viable with cost effective technology and the architecture to support it.

It needs to be recognized that the science of ITS is still in its infancy. The National ITS Architecture was only initially released in 1997, establishing a framework for technology implementation over the next twenty years driving towards this long range vision for ITS. It also needs to be recognized that federal, state, regional, and local government agencies have to work closely with private sector industries to achieve the advances in technology and to share what traffic management data is available to plan further improvements and progress in the ITS and transportation management business.

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The CHART program fits into the early phases of the National ITS Architecture vision like many other state and local government organizations — by concentrating on the management of traffic flow, the coordination of responses to incidents, the providing of traveler advisories, and the gathering and providing of the data necessary for further analysis and planning. The CHART vision is comprised of four major categories of business objectives:

1. CHART is intended to be a statewide traffic management system, not limited to one or two specific corridors of high traffic volumes, but expandable to cover the entire state as funds, resources, and roadside equipment become available to support traffic management.

2. CHART is intended to be a coordination focal point, able to identify incidents, congestion, construction, road closures and other emergency conditions; and then able to direct the resources from various agencies, as necessary, to respond to recurring and non-recurring congestion and emergencies. It should also manage traffic flow with traveler advisories and signal controls, and coordinate or aid in the cleanup and clearance of obstructions.

3. CHART is intended to be an information provider, providing real-time traffic flow and road condition information to travelers and the media broadcasters, as well as providing real-time and archived data to other state agencies and local, regional, inter-state, and private sector partners.

4. CHART is intended to be a 7 day per week, 24 hours per day operation with the system performing internal processing and status checks to detect failed system components and resetting or reconfiguring itself where appropriate, or notifying operators and/or maintenance staff where necessary for service.

During the CHART Visioning sessions, CHART management and operations staff expressed many aspects of their vision for CHART from both a business and system perspective. These vision statements were previously published in vision meeting minutes documents. As this BAA Report is limited to the operations aspects of Traffic Management, not all the expressed vision statements for CHART have been addressed. The following three tables summarize which aspects of the vision statements are addressed in this BAA Report and provide a scorecard to determine those aspects of the vision requiring further analysis to achieve the overall vision for CHART.

In the first and second tables, the statuses of "Full," "Part," and "None" are used to identify the extent to which these vision statements have been addressed within the scope of this BAA Report. The third table uses "Yes" and "No" to identify the NIA User Services covered by this BAA Report.

The first vision statements table summarizes the status of vision statements addressed as related to the Catalyst Domains of Change.

Vision Statement	Full	Part	None	Comments
Business Process: *CHART II is an appropriately automated, fully integrated system that operates seamlessly across jurisdictional boundaries and permits effective multi-modal monitoring, control, and performance evaluation by the appropriate entities.*				
Faster response = faster recovery = lives saved				To be evaluated over time
Better verification of incidents				To be evaluated over time
Incident location identification (ramp IDs?)	Full			Geographical location
Incident assigned to one person		Part		Assigned to one Center
Prediction of the magnitude of an incident			None	
All responses to incidents are pre-planned		Part		
Automate the response to incidents		Part		For detector based and operator initiated incident responses
Integration of agency response	Full			
Incident queue monitoring	Full			Assuming detector availability for specific applications
Arterials considered in incident response		Part		For FITM scenarios
Pre-planned incident response plans		Part		
Organization: *The CHART II system is an appropriately automated, user friendly system that requires minimal training and fosters inter-organizational coordination among all groups involved in surface transportation for the sharing of information and management of resources.*				
Planning and CHART share devices — no system should disable devices		Part		Device *data* is available to Planning through the Archive, as well as CCTV when available
Not just SHA -> Statewide and all operating agencies		Part		Potential exists, limited by SHA infrastructure and areas of responsibility

Vision Statement	Full	Part	None	Comments
Shared application capabilities "like an internet"	Full			Potential exists for CHART applications
Shared coordination of agencies through system capabilities		Part		As related to responses to Incidents and Actions
Manage all traffic incidents	Full			Related to state highways and arterials
Location: *CHART II is a statewide system that includes all major transportation facilities for highway and transit in all counties and Baltimore City. CHART II includes an interconnected system of transportation operation centers located in all agencies (state, local, regional, and federal) involved in transportation management. CHART II contains both fixed and mobile subsystems.*				
Virtual SOC	Full			
Application *CHART II is a truly integrated and interoperable statewide system of transportation applications in partnership with organizations that provide transportation management, information, and emergency services. This will enhance mobility while minimizing the economic and environmental impacts.*				
Click on device on map and get speed/volume information	Full			
Easy way to retrieve data without Oracle expertise		Part		To be determined at Design Phase — use of COTS reporting package
Include weather system data/conditions	Full			
To expand coverage – FITM routes and major arterials	Full			
Identify failures	Full			
Support #77 data capture	Full			
Exploit CCTV to the greatest extent possible (Verification, Critique tool, Training)		Part		No specific processes for critique and training
Real-time collection of incident data	Full			
Landmarks tied into map	Full			
Real-time incident status	Full			
System determined sharing of resources	Full			

Vision Statement	Full	Part	None	Comments
Status of construction		Part		Information will be extracted from EORS
Automated information exchange		Part		
"CHART- Lite" for other (non-operational) agencies	Full			Design factor to be followed in Design and Development phases
Data *CHART II provides a framework to collect, analyze, disseminate, and utilize accurate real-time and archived transportation data from all current and future sources in an open and accessible format.*				
Download data to manipulate it for performance measures	Full			
Download data to manipulate it for planning (Construction, Maintenance, Traffic Management)	Full			
Speed, occupancy, flow rate (individual, average, and variance)	Full			
Monitoring data for travelers — Travel rate index (*vs.* benchmark), Predictive measurements, Emphasis on customer useable data, Disclaimer			None	Current Detector data versus historical
Acquire and share data from other agencies		Part		Data interchange standards to be developed in Design Phase
No jurisdictional boundaries for dissemination	Full			
Correlate Monitoring with Incident Management	Full			Detector-based congestion and incident response
Cost/Benefit analysis		Part		Data capture to perform analysis
Calculate travel time and origin/destination			None	
Correlate monitoring w/ VMS & TAR	Full			
Transit data			None	
Data interface with simulation package	Full			
Ability to have duration data (duration of incidents)	Full			
Ability to evaluate data for changing sensor locations, density, etc.	Full			
Categorize data for recurring/non-recurring special events	Full			

Vision Statement	Full	Part	None	Comments
Data should be lane specific	Full			
Data must be referenced geographically	Full			
Availability of database of historical video clips			None	
Device status and history	Full			
The ability to critique incident response	Full			Part of Simulation
Automatically compute cost benefit		Part		Archive report
Import/export information from other agencies/systems		Part		Data interchange standards to be developed in Design Phase
Technology: *The CHART II system is based upon requirements driven technology that allows for an open architecture and modular applications and is capable of evolving as functional, performance, and technological needs change.*				
Parking monitoring and ramp metering			None	
Data should be available in the field		Part		This capability is being considered for future releases of CHART
In-vehicle systems		Part		AVL
Integrate CAD's (Computer Aided Dispatch)			None	Capabilities needed for this will be determined through a separate effort and possibly incorporated into future releases of CHART
Multi-modal multi-jurisdiction status notification system		Part		Notification is via Pager, Fax, and/or E-Mail. Additional capabilities be identified through the functional visioning effort and incorporated into future releases of CHART

Figure 1-1. Vision Statements by Domain of Change

The second vision statements table summarizes the status of vision statements addressed as related to the CHART Business Objectives.

Vision Statement	Full	Part	None	Comments
Business Objectives				
Managing Non-Recurring Transportation	Full			

Vision Statement	Full	Part	None	Comments
Conditions				
Managing Recurring Transportation Conditions	Full			
Managing Transportation Data and Information	Full			
Develop a cost effective operating capability that is efficient to maintain	Full			
Specific Strategies				
Managing Non-Recurring Transportation Conditions				
Benchmark	Full			
Apply technology aggressively	Full			
Conservative integration of signals	Full			
Managing Recurring Transportation Conditions				
Benchmark	Full			
Apply technology aggressively	Full			
Execute inter-jurisdictional agreements for inter-operable deployment of technology and operations			None	
Use technology to share resource availability between jurisdictions		Part		
Deploy incident detection and validation devices, software, and algorithms	Full			
Evaluate alternative response plans for incidents	Full			
Managing Transportation Data and Information				
Make access to near-real-time and archived data/information easily available to authorized customers	Full			
Develop a cost effective operating capability that is efficient to maintain				
Benchmark	Full			
Application of aggressive technology	Full			
Identify commonly used Operations and Management data types specific to specific devices	Full			
Proceduralize	Full			
Automate	Full			
Allocate to appropriate staff level	Full			
Train	Full			
Critical Success Factors				
Architecture accommodates scalability to	Full			

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Vision Statement	Full	Part	None	Comments
add new device types				
Provide valuable information	Full			
Demonstrate improvement using performance objectives	Full			
Ensure courteous, personalized, and responsive public service		Part		Covers responsiveness
Critical Business Issues				
Scope creep (both within the business and the system)		Part		Limited to SOC/TOC area of responsibility
Resource sharing	Full			
Y2K issues that could possibly cause CHART to shut down		Part		Principal to be applied in Development Phase
Coordination between different development projects			None	
Customer Needs Summary				
Emergency	Full			
En Route Driver Information	Full			
Route Guidance			None	
Traffic Control		Part		Traffic surveillance
Incident Management	Full			
Highway-Rail Intersection			None	
Demand Management Operations			None	
Pre-Trip Travel Information		Part		CHART web site
Public Transportation Management			None	
En Route Transit Information	Full			
Electronic Payment Services			None	
Commercial Vehicle Administration Process			None	
Hazardous Material Incident Response			None	
Emergency Notification & Personal Security			None	
Emergency Vehicle Management		Part		AVL

Figure 1-2. Vision Statements by CHART Business Objective

The third table summarizes the status of the User Services of the National ITS architecture as they relate to what will be provided by CHART. Some of the User Services shown below are not part of CHART because the initial implementation of the CHART system is viewed as an operational application for SHA and the management of traffic on the state highways and the arterial roadways.

National ITS Architecture User Service	Provided by CHART
1.0 Travel and Traffic Management	
1.1 Pre-Trip Travel Information	Yes
1.1.2 Current Situation Information	Yes
1.1.4 User Access Information	Yes
1.2 En-Route Driver Information	Yes
1.2.1 Driver Advisory	Yes
1.3 Route Guidance	No
1.6 Traffic Control	Yes
1.6.2 Traffic Surveillance	Yes
1.7 Incident Management	Yes
1.7.1 Scheduled Planned Incidents	Yes
1.7.2 Identify Incidents	Yes
1.7.3 Formulate Response Actions	Yes
1.7.4 Support Coordinated Implementation of Response	Yes
1.7.5 Support Initialization of Response Actions	Yes
1.7.6 Predict Hazardous Conditions	Yes
1.8 Travel Demand Mgmt.	No
1.8.1 Communications Function	No
1.8.2 Processing Function	No
1.10 Highway-Rail Intersection	No
2.0 Public Transportation Management	
2.1 Public Transportation Management	No
2.2 En-Route Transit Info.	No
3.0 Electronic Payment	
3.1 Electronic Payment Services	No
4.0 Commercial Vehicle Operations	
4.4 Commercial Vehicle Administrative Processes	No
4.5 HazMat Incident Response	No
5.0 Emergency Management	
5.1 Emergency Notification & Personal Security	No
5.2 Emergency Vehicle Management	Yes
7.0 Information Management	
7.1 Archived Data	Yes
7.1.1 Historical Data Archive	Yes
7.1.2 Operational Data Control	Yes
7.1.3 Data Import & Verification	Yes
7.1.4 Automatic Data Historical Archive	Yes

Figure 1-3. NIA User Services Provided by CHART

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1.5 Overview of the Future CHART II System

1.5.1 Business Processes

The CHART program provides statewide traffic management services for the state highways of Maryland. Traffic management as performed by CHART is comprised of five major groups of processes. The following groups of future processes are illustrated in the following diagram and defined in the following
paragraphs for the
CHART II system.

TRAFFIC
MONITORING,
DETECTION,
VERIFICATION

INCIDENT,
TRAFFIC,
OPERATIONS
MANAGEMENT

TRAVELER
INFORMATION

PERFORMANCE
MEASUREMENT
AND
TRAFFIC FLOW
ANALYSIS

EXTERNAL
TRANSPORTATION
MANAGEMENT
SYSTEM
INTERFACE
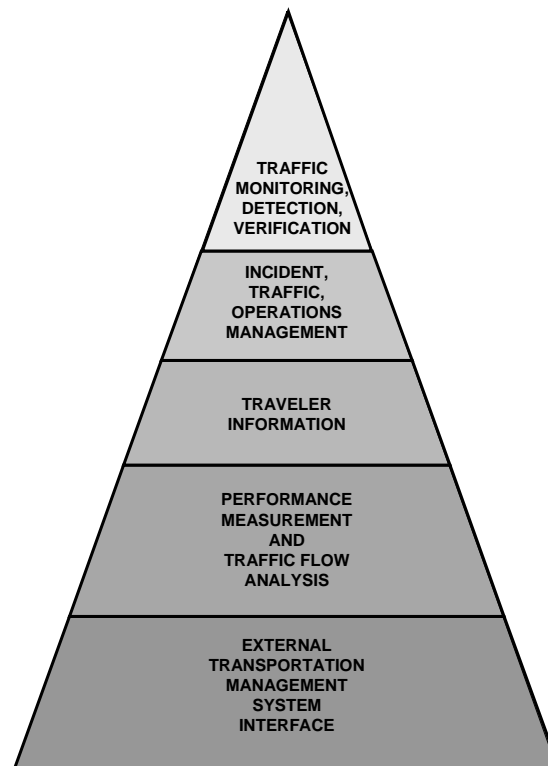
Figure 1-4. CHART Business Process Groupings

1. Traffic monitoring, detection and verification — CHART utilizes various technologies for monitoring traffic flows and roadway conditions to detect problem spots requiring attention. Some of the technologies include CCTV, telephone, radio, roadside detectors, roadside weather stations, and traffic counters tied to signal controllers.
2. Incident, traffic, operations management — CHART manages ten specific types of activities as related to the management of incidents, traffic flow, and operational management of the program. These ten activities have been related to logs that will be utilized to identify each event and record the actions taken to manage the particular event. These logs then form the basis for performance measurement data and are the basis for analysis and simulation of CHART responses to study and formulate better response capabilities in the future.
3. Traveler information — CHART provides traveler information to the media, the traveling public and to other traffic management organizations for pre-trip planning, en-route planning, public travel safety, and scheduled planned closures. Traveler information is dispersed

through roadside devices (DMS and HAR), over the Internet, through sharing of CCTV video streams, and through sharing of stored data.

4. Performance measurement and traffic flow analysis — CHART archives data related to traffic flow, weather, and the activities managed by the program to establish and maintain a data set by which statistical and operational performance measurements can be calculated and evaluated, and reenactments of activities may be simulated and evaluated for best practices.

5. External transportation management system interface — CHART provides automated interfaces to other jurisdictional traffic management systems so as to be aware of traffic situations in those jurisdictions and to provide appropriate traveler information to travelers approaching those jurisdictions or those travelers approaching CHART managed roadways.

1.5.1.1 Traffic Monitoring, Detection and Verification

TRAFFIC MONITORING, DETECTION, VERIFICATION

PHONE	RADIO	DETECTOR	SENSOR	SIGNAL	CCTV
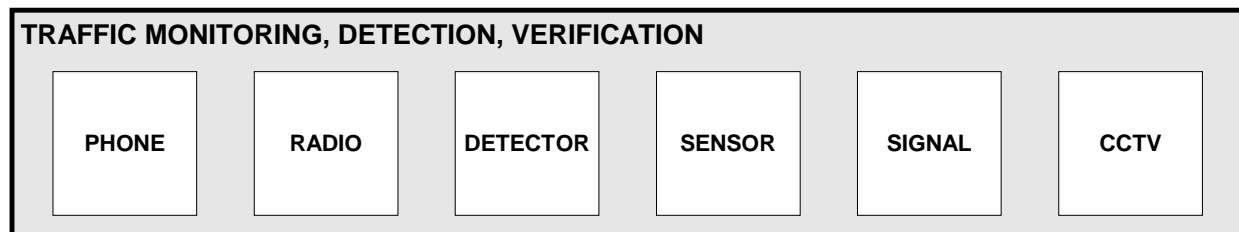
Figure 1-5. Traffic Monitoring, Detection and Verification

CHART utilizes both manual and automated capabilities to monitor, detect and verify traffic conditions.

CHART operators manually receive reports of incidents, traffic congestion and maintenance needs (signal outages, broken signs, debris in roadway, etc.) via telephone and radio. Most of the telephone calls come through the statewide #77 telephone system from the MSP, others are direct calls to the SOC and TOC's. Radio calls are received from the MSP, CHART Emergency Traffic Patrol (ETP), and CHART Emergency Response Unit (ERU) vehicles. Manual operator initiation of a CHART log is required to record the activity and the responses made to the reported situation.

CHART receives traffic flow data from detectors and Signal traffic counters to monitor traffic flow. CHART analyses this data, comparing it to calculated "normal" traffic flows and determines abnormal traffic flows. Results of the CHART analysis may result in the automated alerting of CHART operators to abnormal traffic conditions, and the automated initiation of a CHART log and an automated response to the condition. CHART also receives data from Weather stations and road surface sensors. CHART analyses this data and determines when hazardous driving conditions exist. When hazardous driving conditions are detected, CHART alerts operators and initiates a CHART log and an automated response.

CCTV are primarily used to verify reported or detected traffic incidents, congestion and required maintenance activities, but occasionally may be a manual method of detecting traffic problems. As the location of a traffic problem is identified to CHART, the system will attempt to select a CCTV within a specified range of the location and give control of that CCTV to the operator to verify the traffic situation.

1.5.1.2 Incident, Traffic, Operations Management

INCIDENT, TRAFFIC, OPERATIONS MANAGEMENT

INCIDENT MGMT	TRAFFIC MGMT	OPERATIONS MANAGEMENT		
INCIDENT	CONGESTION	COMMUNICATIONS MGMT COMMUNICATIONS	HIGHWAY MAINT MGMT ACTION	TRAVELER SPT MGMT DISABLED VEHICLE
	RECURRING CONGESTION			WEATHER ADVISORY
	SPECIAL EVENT		WEATHER SENSOR	
	SAFETY MESSAGE			
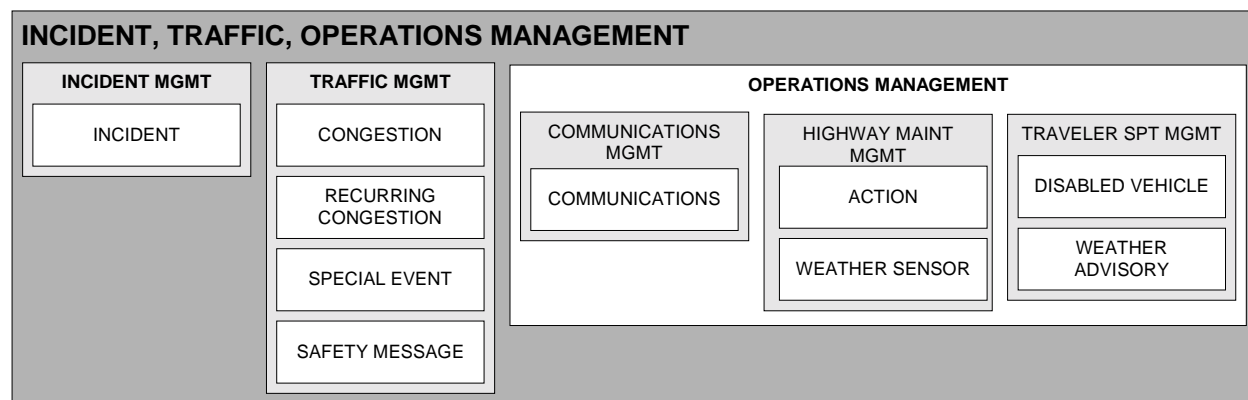
Figure 1-6. Incident, Traffic, Operations Management

The CHART system supports the management of CHART activities through the use of logs. Logs are used to identify each occurrence of each type of activity performed by the CHART program, and to track each action taken in response to the activity until the occurrence is completed and the log is closed. Responsibility for managing an activity or log is controlled by assigning a log to one of the operating centers defined in the system. Responsibility may be transferred between operating centers by assigning a log to another operating center.

In addition to using logs to manage CHART program activities in-process, archived log data form the basis for performance measurements and provide data for simulation exercises.

The ten activities and log types are identified and defined in the following table.

Log Type	Description
Action	Action log is for managing a maintenance type activity requiring coordination with other SHA organizations to make repairs or cleanup to highways or traffic control devices. Operator initiated Action logs are usually related to signal outages, debris in the roadway or utility repairs. System initiated Action logs are related to failures of CHART devices or system components.
Communication	Communications log is for recording all *non-action* required communications. Primarily used to record in-service/out-of-service calls. As most activities are started via phone or radio calls, most operator-initiated logs begin as Communication logs and then change to their specific activity type.
Congestion	Congestion log is usually a system-initiated log based on congestion situations determined from data received from detectors. May be operator initiated where no detectors are available or notification of congestion is received via other means. Analysis of Congestion logs may be used to aid in the identification of recurring congestion spots.
Disabled Vehicle	Disabled Vehicle log records identification and location of disabled vehicles and actions taken to remove the vehicle or in obtaining assistance for the motorist. These logs my be operator initiated or system initiated (via the AVL processes).

Log Type	Description
Incident	Incident log identifies planned and non-planned roadway closures. Includes road construction closures based on EORS permits as well as accidents. Identifies actions taken, people/organizations notified, vehicles dispatched/on-scene, queue length, duration, etc. These logs may be operator-initiated or system-initiated (by the analysis of detector data).
Recurring Congestion	Recurring Congestion log is usually system initiated when a pre-scheduled set of actions is executed to manage recurring congestion. The log records the location of the recurring congestion and the actions taken. This log may be operator initiated to support short-term recurring congestion or to test response actions before committing the set of actions to the automated scheduler.
Special Event	Special Event log identifies and records actions taken to manage congestion related to sporting events, parades, etc. The log may be system initiated if actions are preplanned and scheduled, or may be operator initiated and controlled.
Safety Message	Safety Message log identifies the use of devices to display/broadcast safety information. This log type is system initiated when pre-planned actions are scheduled, but may be operator initiated for special situations or to test actions before committing to the automated scheduler.
Weather Advisory	Weather Advisory log identifies the use of devices to display/broadcast weather advisory information. This log type may be operator-initiated and identifies any actions taken as a result of an operator being alerted to receipt of Subscription Weather Service bulletin, or may be system-initiated upon the declaration of county snow emergencies. Actions may include display/broadcast of traveler information, people notified, dispatch of support services, etc.
Weather Sensor	Weather Sensor log is usually a system-initiated log in response to system analysis of pavement and weather sensor data identifying unsafe road surface or weather conditions. May be operator-initiated in response to phone/radio notification of unsafe conditions. Records the unsafe conditions and actions taken to alleviate the conditions and/or to advise travelers of the conditions.

Figure 1-7. CHART II Log Types and Descriptions

1.5.1.3 Traveler Information

```
┌─────────────────────────────────────────────────────────────────────────────┐
│ TRAVELER INFORMATION                                                          │
│                                                                               │
│                                          MEDIA / INFORMATION PROVIDER SUPPORT │
│  ┌────────┐  ┌────────┐  ┌────────────┐  ┌──────────┬──────────────────────┐  │
│  │        │  │        │  │ SHA WEB PAGE│ │          │  INCIDENT            │  │
│  │  DMS   │  │  HAR   │  │  SUPPORT   │  │   CCTV   │  INTERCHANGE         │  │
│  │        │  │        │  │            │  │          │  DATABASE            │  │
│  └────────┘  └────────┘  └────────────┘  └──────────┴──────────────────────┘  │
│                                                                               │
└─────────────────────────────────────────────────────────────────────────────┘
```
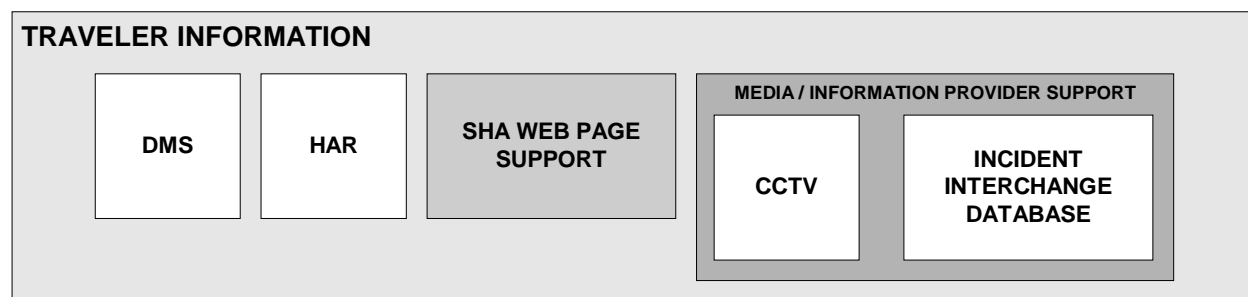
Figure 1-8. Traveler Information

The CHART system supports and controls the disbursement of traveler information to various devices, systems, and organizations.

The primary means of providing en-route traveler information to Maryland's motorists is through Dynamic Message Signs (DMS) and Highway Advisory Radio (HAR). The CHART system supports the use of these devices through the use of message libraries to provide operator access to pre-recorded messages organized by topic and simplified user interfaces to select messages and related devices. The system is designed to aid users in resolving contention for use of the devices by providing message prioritization and arbitration capabilities. These capabilities allow operators to assign messages to devices, and let the system determine which of multiple messages designated for a single device actually gets displayed or broadcast.

These capabilities include: a) maintenance of a message queue for each device, b) an arbitration algorithm to determine message priorities, and c) appropriate processes to display/broadcast messages on designated devices, remove messages from devices, and interface with log processes to record actions of when messages are queued *and* when they are actually sent to or removed from the devices. Capabilities are also provided for authorized operators to force non-standard priority levels on messages when the situation may require some variation to the standard process.

The SHA maintains a Web page for pre-trip planning, providing the public with traffic flow information, video feeds, and weather sensor data and pictures. CHART provides capabilities to make data available and to control the access to the video feeds presented on the Web page. One specific capability of CHART is the ability to stop video feeds from going outside of CHART in the event that an operator takes control of a camera for any reason.

In order to provide information to other organizations and to the media, there is a closed-circuit television (CCTV) system and an Incident Interchange Database. The CCTV system is used for traffic monitoring and various feeds from the system are made available to other organizations (*i.e.,* Montgomery County) and a media interface will also be added to the SOC system which will allow the media to access higher quality real-time traffic video.

Maryland is a member of the I-95 Corridor Coalition, which is comprised of 26 agencies/organizations responsible for transportation along the northeast section of the corridor from Virginia to Maine. The Coalition's mission is to "work cooperatively to improve mobility, safety, environmental quality and efficiency of inter-regional travel in the northeast through real-time communication and operational management of the transportation system. In doing so, the

Coalition seeks to establish an economically beneficial multi-modal framework for early implementation of appropriate ITS technology."

To carry out this mission, the Coalition has established the goal of implementing a set of integrated traffic management and traveler information systems along the I-95 corridor. CHART will provide the key I-95 Coalition link in Maryland by implementing an Incident Interchange Database. The Incident Interchange Database will be a separate database that will have a subset of data for incidents. Information to be stored will be incident ID information, such as*: location, lane closure information, type of incident, queue length,* and *estimated clear time.*

1.5.1.4 Performance Measurement and Traffic Flow Analysis

PERFORMANCE MEASUREMENT AND TRAFFIC FLOW ANALYSIS

Incident, Traffic,Operations Management	Archive	Detectors	Weather Sensors	Signals
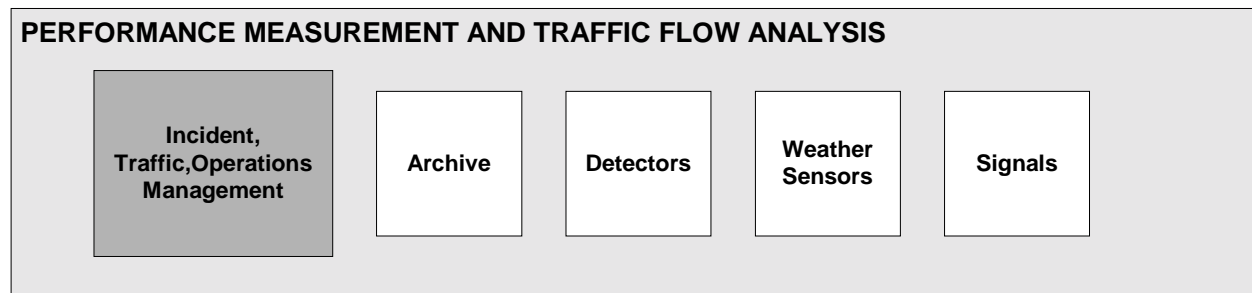
Figure 1-9. Performance Measurement and Traffic Flow Analysis

CHART organizes and stores data for the purposes of calculating performance measurements and performing traffic flow analysis.

CHART stores data related to operational events/logs (described in the Incident, Traffic, Operations Management section above) in an online, operational database for a period of 14 days (or until a log is closed). Each day, the current day's data is copied to the Archive database for offline access. Traffic flow analysis data from detectors, weather sensors, and signals is downloaded to the Archive database on a daily basis. In this manner, the Archive database is never more than 24 hours out of date with the operational activities. Data for performance measurements is contained in both the operational database and the Archive database. Data for traffic flow analysis is stored in the Archive database.

PERFORMANCE MEASUREMENT DATA

CHART utilizes logs to identify and organize data related to each activity performed by the operations staff. Each log identifies a single traffic or operational event, providing a means to manage the event and to record all activities related to the specific event. Each log includes data identifying the operational center managing the event and event-level data to capture the start/end times and the status of the event. Open logs indicate the current events in progress and are used to identify the current work in process. Any activity related to a log is recorded as part of the log (DMS, HAR, Alerts, Notifications, actions taken by other organizations, etc.).

The CHART logs form a basis for calculating operational performance measurements. From these logs SHA/CHART management can calculate numbers of events, average duration of events, frequencies of types of events, numbers of events per specific roadway or operational

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center, etc. Data contained within these logs can be analyzed to determine the numbers of times messages were displayed on DMS's or broadcast on HAR's, which signs or radios were used, and the numbers of messages related to event types.

Because CHART utilizes a queuing approach to control contention for use of individual signs and radios, the logs identify when messages are initially queued, when they are actually displayed or broadcast, when they are removed from the sign or radio, etc. Analysis of these timings may disclose specific signs and radios having high usage and contention, and thereby identify locations for additional devices.

TRAFFIC FLOW ANALYSIS

Detector data, weather sensor data, and signal data is downloaded from respective devices on a daily basis to the Archive database. This data is maintained in raw data format. Traffic engineers having access to the Archive database may analyze the data in the Archive, or download the data to their respective analysis tools.

SIMULATION

The Archive database contains both operational event data and detector/sensor data, thereby providing highway conditions for traffic flow and identification of any actions taken by the CHART operations staff. Through use of Simulation tools capabilities, this data can be combined and analyzed to review/display actions taken by the operations staff (display of signs, etc.) and the resultant change in traffic flows. This analysis can then be utilized in various ways to analyze successful and unsuccessful traffic management methods and form a basis to demonstrate and train the operations staff in better methods.

1.5.1.5 External Transportation Management System Interface

EXTERNAL TRANSPORTATION MANAGEMENT SYSTEM INTERFACE

PROVIDE / RECEIVE INFORMATION

| Partners In Motion | Transcom | Media | Other Maryland Agencies |

EXCHANGE & CONTROL

| Montgomery County | VDOT |
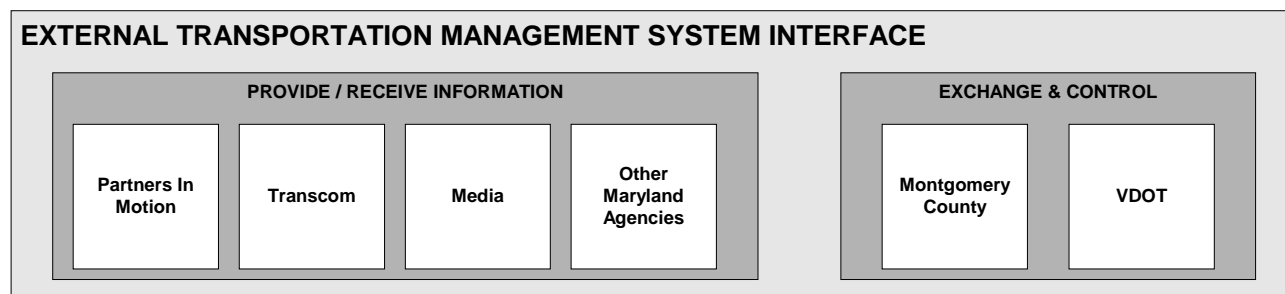
Figure 1-10. External Transportation Management System Interface

CHART provides incident information to traffic management partners through an Incident Interchange Database. These partners include the media, public traveler information providers, and traffic management organizations of other states and other Maryland jurisdictions. As basic Incident information is collected and updated in CHART, the Incident Interchange Database is updated. Partners are expected to periodically review this database to obtain Incident information related to Maryland's state highways.

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CHART provides incident information to specific Maryland government agencies and offices through its Notification process. This process provides Fax, e-mail, or pager delivery of Incident information similar to the data stored in the Incident Interchange Database.

In addition to exchanging Incident information with nearby state and regional traffic management organizations, CHART would like to have a more direct system interface in which CHART operators could view selected cameras and control selected signs. Camera viewing would be useful to monitor traffic flows near the Maryland borders so that travelers could be warned of congestion or incidents ahead. Conversely, use of signs in these other systems could be used to advise travelers of conditions as they enter Maryland. The goal of establishing system interfaces with these organizations is in keeping with the vision of the National ITS Architecture, but it should be expected that these CHART goals may be politically and technically challenging.

1.5.2 Organization

This section presents the organizational structure for CHART, and specifies the expected duties of the organizational entities, as related to the deployment of a new CHART system. There was no intent in the BAA exercise to analyze and recommend a re-organization of the CHART organization, but merely to understand the organization and to make suggestions for training needs for the CHART II system.

The following diagram shows the current CHART Organization:

CHART Organization Chart
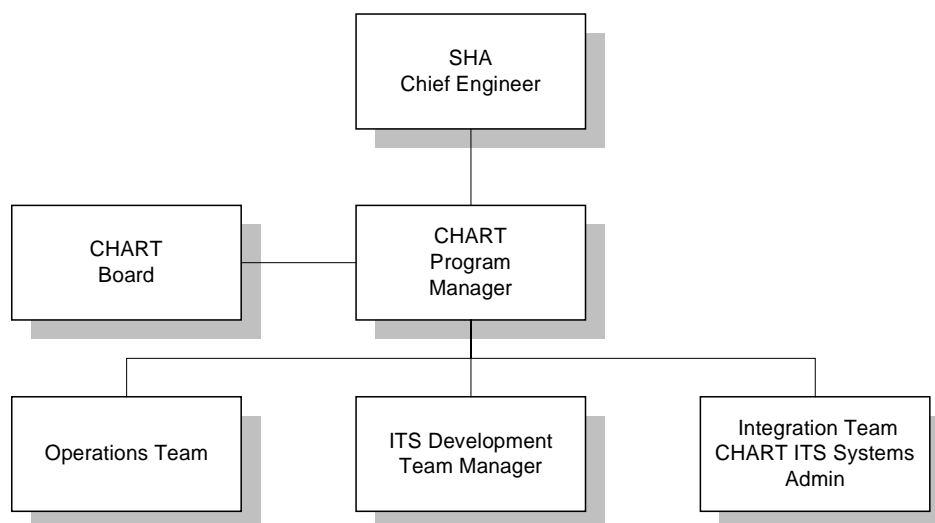
Figure 1-11. CHART Organization Chart

The position of "Chief Operator" does not currently exist, but the need for it was mentioned in Visioning and Process Design Workshops. This position is envisioned as part of the Operations Team, and would be used to arbitrate conflicts and be the main point of contact for internal and external customers when responding to traffic incidents. This position would be staffed at all times (24x7), and would be responsible for coordinating intra-agency activities, and serve as a single point of contact to coordinate and take responsibility for inside operations (device activation and resource notification). This would also assist with times when calls for information come in and no single point of contact (team leader) is available to handle this responsibility by being the point of contact for information requests. Other than the Chief Operator position, it does not appear necessary to change staffing levels of the CHART organization at this time. This is because the organization has been, in the past, and should also be able in the future, to shift staff to needed areas in times of high demand.

The following table identifies the major responsibilities of the organizational entities as related to the deployment, management, and operation of the CHART system described in the other sections of this document. The responsibilities identified in this table also reflect many of those responsibilities necessary to continue the growth of CHART, as well as support the continuing efforts to further integrate other systems and transportation models into a state-wide ITS.

Organizational Entity	Major Responsibilities
SHA Chief Engineer	• Strategy and Planning • Manage budget and funding • Define business objectives
CHART Program Manager	• Strategy and Planning • Manage budget and funding • Define, measure, and manage business objectives • Define and monitor operational objectives
Operations Team	• Traffic management of state highways and arterials • Manage ETP, ERU and HOT operations • Monitor, measure, and manage operational accomplishments • Plan, prepare, and conduct ER training
ITS Development Team Manager	• Investigate new technologies • Develop ITS strategy • Define ITS objectives • Manage ITS development and deployment

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Organizational Entity	Major Responsibilities
Integration Team — CHART ITS Systems Admin	• ITS Systems planning and strategy • Maintain infrastructure equipment and configuration • CHART application administration and configuration • Network administration and maintenance • Legacy systems administration • Applications change control and configuration management • CHART application maintenance • Database administration • CHART functional and user training

Figure 1-12. CHART Organizational Responsibilities

Many of the major responsibilities for the *Integration Team — CHART ITS System Admin* organization are expected to be supported by contract personnel during the development of CHART II and, afterwards, as part of application maintenance and hardware maintenance contracts.

1.5.2.1 Training Requirements

Deployment of a new system can have an adverse affect on an organization, unless appropriate training is provided. With so many of the aspects of the new system being different from the old system and the system environment, several types of training will be required to prepare the organization to effectively utilize, administer, and maintain the system. The three types of training, which have been identified as necessary, are: Technical, Functional, and User Application training.

Technical Training
• Windows NT 4.0 – To assist system administrators and users with understanding the complexities of Windows NT.
• System support training in UNIX, Oracle, ATM Switch, Coastcom Mux, Routers, etc.

Functional Training
• CHART Application Administration – To provide a functional overview of the system parameters and configuration data used in the CHART applications to control the processing options and flexibility of the applications.
• CHART User Functions – To provide the users with a conceptual view of the processes supported by the CHART applications. Introducing users to any new terminology, situations to utilize each function, and the business objectives and reasons for performing each function.
• CHART Archive Data – To provide users with an overview of the data being retained in the Archive Database and its logical structure and relationships

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User Application Training
- CHART Application User Training – To provide CHART users with application-level training, and to be directed to training individuals in the use of the CHART II application at a screen level.
- CHART Archive Training – To provide Archive users with instructions on use of standard and alternative tools to select, extract, and report on data in the Archive.

1.5.3 Location

The BAA for CHART II focused mainly on the traffic operations of the State of Maryland's state highways and arterial roadways. As a result, the locations identified for the CHART II system were SHA- and state-centric. As identified in the BAA workshops, the following locations were identified as having varying degrees of functionality available to them when using the CHART II system:

- SOC/TOC/AOC – SHA Traffic Operations Center operations and traffic management personnel will be responsible for monitoring traffic and roadway conditions and evaluating actions that need to be taken. Personnel will be communicating with Maryland State Police, ERU and ETP operators, and the various maintenance shops. These locations will have the most capabilities and control when compared to the other CHART II locations, since they will be handling most of the coordination efforts to manage the traffic flow of the roadways.

- Districts – District Offices personnel will be primarily monitoring select information, and also perform some highway maintenance supervision. These locations will mostly be viewing the information and will not be active participants in the system.

- SHA Highway Maintenance – Highway maintenance shop personnel will be responsible for structural repairs, road signs and posts, potholes, guard rails, etc., which may be contributing to degrading traffic conditions. In many cases the maintenance shops will need to assist by providing the following equipment or materials: Arrow boards, dump trucks, light plants, loaders, sand, sweepers, etc. Main responsibilities in the CHART II system will be to respond to Action and Incident Logs.

- Device Maintenance: Signal Crew – Signal control and repair personnel will be mainly responsible for responding to signal failure alerts/Action Logs in the CHART II system.

- Device Maintenance: Radio Shop (HAR) – Radio maintenance personnel will be mainly responsible for responding to HAR, Radar, CCTV, and Weather Tower failure alerts/Action Logs in the CHART II system.

- Device Maintenance : DMS Crew – Dynamic signs repair personnel will be mainly responsible for responding to DMS, PDMS, ATR, and Shazam failure alerts/Action Logs in the CHART II system.

- Maryland State Police – This will included all MSP locations participating in CHART. The MSP will be assisting with traffic management and incident response.

- Media – Outside information re-processors (*i.e.,* television, radio, traffic reporters). These locations will receive filtered incident and traffic flow information, and CCTV video feeds from the CHART II system.

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1.5.4   Application

A conceptual description of the seven future CHART II application areas required to satisfy the CHART II future business needs is shown in the table below. Their order within the following table does not suggest a release sequence or development priority.

Application Area	Description
Traffic and Roadway Monitoring	Monitor traffic and roadway conditions and evaluate roadway detector data.
Incident Management	Provides the operator with tools to assist in incident management and documentation.
Shared Resource Management	Handle allocation and control of shared devices (DMS, HAR) and receive and log roadway detector data.
Status Display Management	Maintain the state of the display map.
System Configuration and Administration	Provides tools for managing and administering the system
Operations Support	Provides user access control and support utilities.
Report Generation	Provide tools for generating reports from system log files.

Figure 1-13. CHART II Application Areas

The CHART II system gives and receives information to and from other sources linked to the system. The diagram below illustrates how the CHART II system will interface with legacy systems, as well as with other external interfaces and COTS software. These applications assist the users of the CHART II system to monitor the roadways, notify individuals and groups that may need to assist with situations or be aware of what's happening, and receive additional information to assist with current or future situations.

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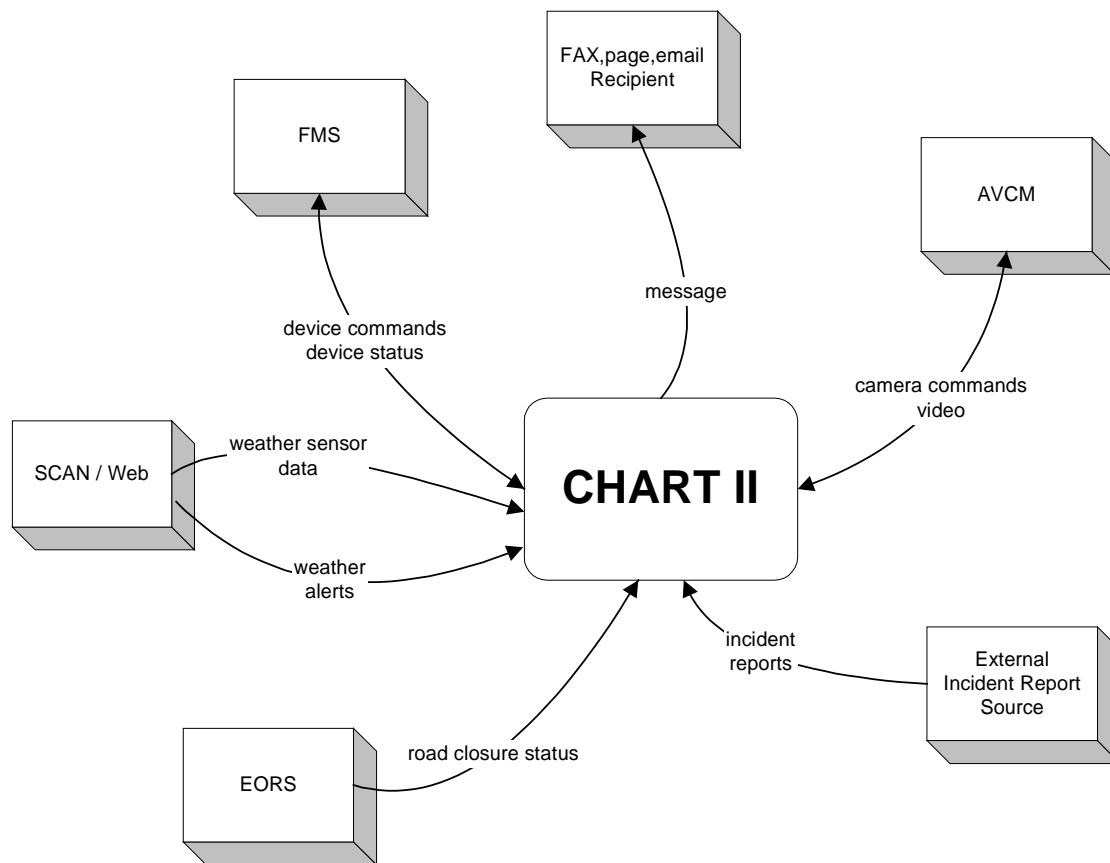
Figure 1-14. CHART Application Architecture Interfaces

Future releases of CHART II will also incorporate a CHART-Lite version of the application, and a Simulation application:

- CHART-Lite is seen to be a fully functional version of the application, that will be deployed anywhere, and communicate with the CHART II system. Although this has not been fully defined, the current vision is that it will be provided via a web interface for ease of use and cost reduction, since having a separate workstation deployed at multiple sites could be very costly and difficult to maintain.

- The University of Maryland will have responsibility for the development of simulation tools for the CHART II system. Further definition of requirements and development will be undertaken at a later date.

1.5.5   Data

One of the most common pitfalls in designing systems is that the data is either not captured and stored, redundant, not traceable, and/or not distributed. As a result, the design of the Oracle database for the CHART II system has been developed with all these pitfalls in mind. The data of the CHART II system is viewed as a valuable asset for not only informational reasons, but also for managerial, process improvement, and legal reasons. All of the operations being carried out by either the system or operators will be captured and stored in a centralized database that can be

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accessed from any of the CHART II workstations. Wherever possible, the database will be highly normalized to ensure that not only will the data not span across multiple tables, but will also be captured only once. As the system matures, the data captured from the system can be used to analyze system performance, incident response, operator efficiency, and assist with training and simulation activities.

To assist with this, there are two types of database repositories:

- Operational database – Real time capture of information. As activities take place in the system, the data will be captured in real-time fashion, not in batch mode. This will allow the data being captured and displayed by the system to be the most current and useful to all the users of the system. This is all the data of the system which is up to 14 days old, and any open logs even if they are open for more than 14 days. The data from this database can also be used for Operational, Administrative, and Management/Statistical reports, as well as real-time simulation activities.
- Archive database – Repository of information of more than 14 days old. The primary uses of information in the archive database are:

    Making information available for other Maryland state agencies,

    Enablement of CHART II simulation,

    Storage of information for legal purposes, and

    Providing data for generating various reports – In additional to the Operational report types generated from the operational database, other type of reports to be made available by the archive database would be Operations (*i.e.,* weather detectors/road conditions, down time of devices/components), Management (*i.e.,* workload reports, resource utilization, cost of incident clearance), and Performance Management reports.

1.5.6 Technology

CHART II is to be a statewide system operating 24 hours per day, 7 day per week schedule. The system must be highly available through redundancy and geographic distribution, and the state of the system (device status, current messages, etc.) shall be maintained and shall persist through a system shutdown and startup cycle.

To satisfy these high level technological requirements, the system requires a mix of communications, hardware infrastructure, and operating system components that support these requirements. The components selected for CHART II to meet these requirements are itemized in the following table:

Category	Components
Hardware	- Standard workstation hardware is 200Mz (or better) dual processor, 256MB memory, 9GB storage. - Standard server hardware is 200Mz (or better) quad processor, 512MB memory, 20GB RAID. - CHART-Lite hardware is 200Mz (or better) single processor, 128MB memory, 4GB storage.

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Category	Components

Software	• Operating system software is Windows NT 4.0 Service Patch 5.
	
	• Standard workstation software suite includes:
	
	  - Novell GroupWise email
	
	  - Microsoft Office
	
	  - Web browser (Netscape or Internet Explorer)
	
	• Standard server software suite includes:
	
	  - Oracle 8I

Communications	• Communications between servers and from servers to the field devices must be available 24 hours/day. • Failure of communications to a server or failure of a server will not affect the ability of other servers from communicating with field devices.

Figure 1-15. CHART Components

The diagram below shows the conceptual architecture of the future system illustrating the use of the CORBA ORB for process communication.
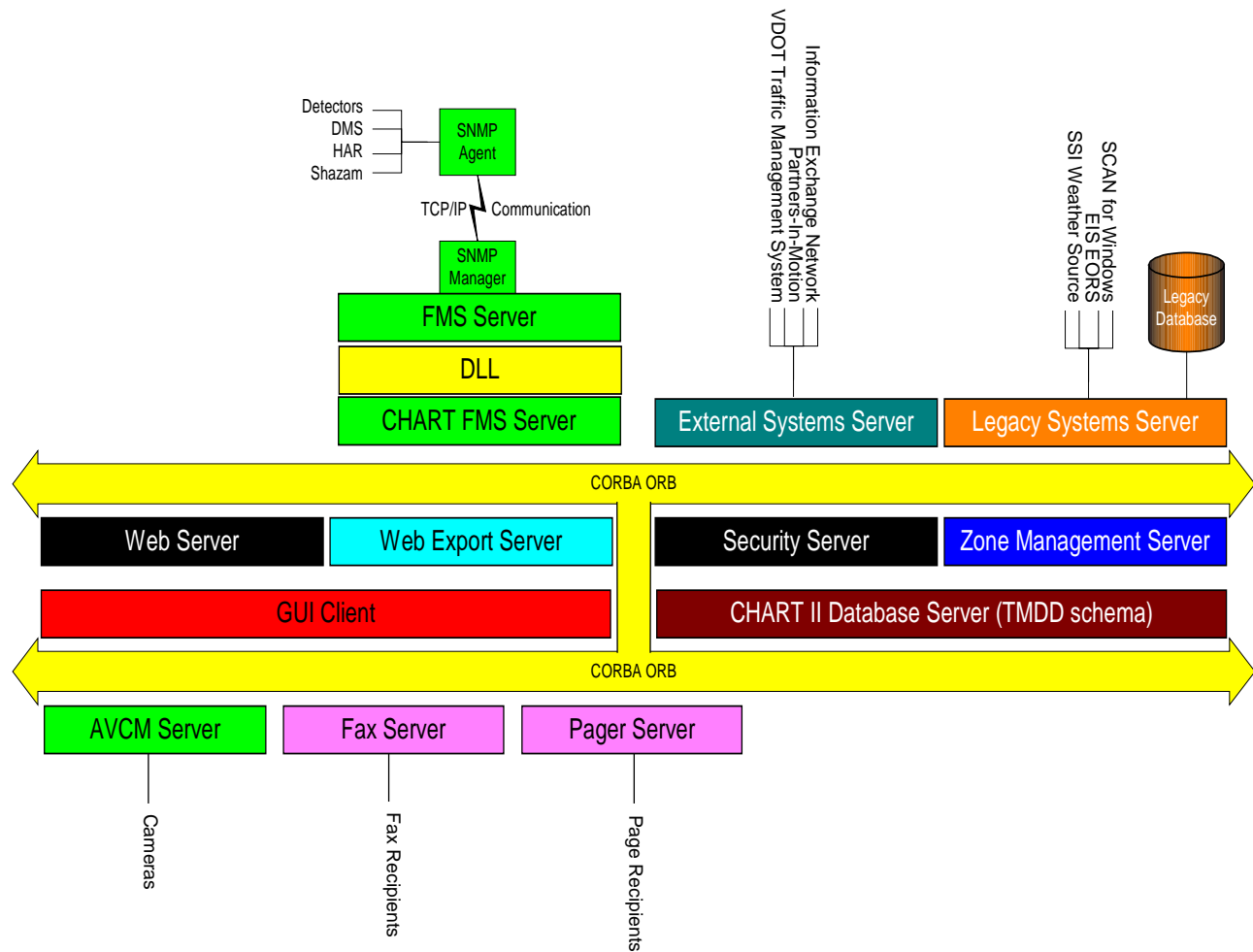
Figure 1-16. CHART Conceptual Architecture

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Below is a network concept diagram showing the system network connectivity.
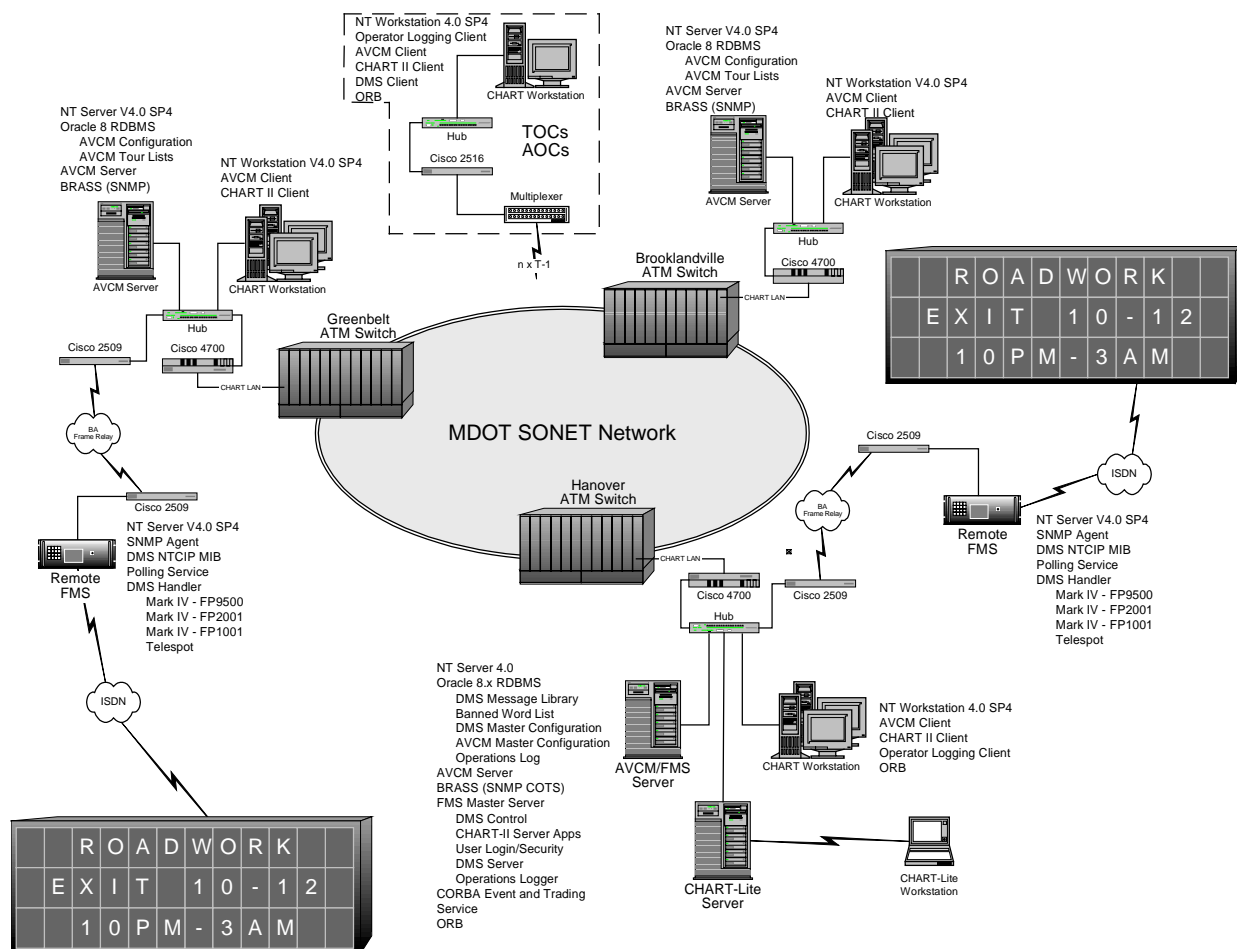
Figure 1-17. Network Diagram

1.6 Performance Objectives of the Future CHART II System

1.6.1 Process Thread Model

The Catalyst Business Process Performance Model identifies the critical business process threads and defines the performance objectives for them. These performance objectives become useful input in designing applications and defining the technical architecture for a system, as well as identifying those business processes that need to be highly reengineered.

The CHART business of Traffic Management is a young business and lacks historical data and best practices related to process performance models. There are many factors to be considered in determining a performance model for traffic management. For example, the performance of a process thread of incident detection through restoration of normal traffic flow is affected by 1) the severity of the incident, 2) the numbers of vehicles involved, 3) the traffic volume at the time (the size of the backup), and 4) the availability of alternate routes, etc. To specify a performance objective on this high a level of thread would be unrealistic. For CHART II, it makes more sense to define and assign performance objectives for lower level threads and attempt to minimize the variables affecting the measurement of those threads.

It has been determined through BAA workshops that CHART operators perform 10 basic activities in their day-to-day roles to manage traffic on Maryland's state highways. The log types being recorded in the CHART II system identify these 10 activities and, therefore, identify the major process threads and subsequent lower level threads for determining performance measurements. The following table identifies the major- and lower-level process threads identified in CHART II, and assigns performance objectives for each. Future time objectives are noted for controllable threads, and the level of required quality is indicated where this is a factor in accomplishing the thread. Examples of variables that might affect the accomplishment of the objectives are identified in the table.

Event	Result	Process Thread	Time	Quality	Variables
COMMUNICATION LOG					
Communications Log Initiation	Communications Log Closure	Comm Log	2 minutes	High level of accuracy	Length of phone call, ease of data entry
ACTION LOG					
Detection of failure from data received from FMS	Alert sent to responsible Center	Action Log – initiated by system detection of device failure	15 seconds	Accuracy of identification of failure	FMS determination of type of failure may affect quality
Action Log initiation	Alert sent to responsible center	Action Log – operator initiated	1-5 minutes	Accuracy of identification of failure	Accuracy of information received by operator, ease of data entry
Alert received at responsible center	Alert acknowledged at responsible center	Action Log – alert acknowledgement	Variable: 30 seconds to 3 days	N/A	Duty hours and staff availability at the responsible center, assumes non-escalated alert
Alert received at the responsible center	Alert escalated and sent to next responsible center	Action Log – alert escalation	Parameter controlled	Accuracy of escalation protocol	Value of system parameter for escalation wait period, priority of alert
Action alert acknowledged	Action completed	Action Log – action completed, log closed	Variable	Accuracy of information received	Type of action required, maintenance staff availability, priority of action

Event	Result	Process Thread	Time	Quality	Variables
DISABLED VEHICLE LOG					
Disabled Vehicle Log initiation, receipt of call from traveler or other agency	Dispatch of CHART vehicle	Disabled Vehicle Log – initiated via phone call	5 minutes	Accuracy of location of disabled vehicle	Ease of data entry, availability and location of CHART vehicles/drivers
Disabled Vehicle Log initiation, radio call from CHART vehicle	Disabled Vehicle Log created	Disabled Vehicle Log – initiated via vehicle on scene	3 minutes	Accuracy of location and vehicle description	Ease of data entry
INCIDENT LOG (Operator Initiated)					
Incident Log Initiation	Incident Verified or Cancelled	Operator initiated Incident Log – Incident Verification	0 – 2 minutes	Accuracy of location and incident description	Availability of camera in near location, source of information
Incident Verified	Completion of Initial Dispatch and DMS/HAR Response	Process initial response	5-10 minutes	High level of accuracy	#'s of Dispatches and DMS/HAR involved, Plan versus operator initiation, ease of GUI use
Initial response complete	Incident cleared from roadway	Incident cleared	Variable	N/A	Number of vehicles, type of vehicles, HAZMAT, load spill, severity of injuries
Incident cleared	Delay cleared	Normal flow restored	Variable	N/A	Duration of roadway clearance, traffic volume, availability of alternate routes
CONGESTION LOG					
Congestion Detected	Congestion Log Initiated, Alert Sent	Process Initial Response	3-5 minutes	Accuracy of location	Length of roadway congestion, time of day, # of DMS/HAR involved
Alert received at responsible center	Alert acknowledged	Response to alert	30 seconds to 5 minutes	Accuracy of information communicated	Accuracy of information from detectors, duty hours and staff availability of staff of responsible center
Additional congestion reported	Congestion log modified	Response to additional congestion	3-5 minutes	High level of accuracy of input	Length of roadway congestion, time of day, # of DMS/HAR involved
Congestion clear	Delay cleared	Normal flow restored	Variable	Accuracy of detector information	Accuracy of information from detectors, response time of FMS
RECURRING CONGESTION LOG					
Recurring Congestion	Recurring Congestion Plan Activated	Initial Response to Congestion	3-5 minutes	Accuracy of plan	# of DMS/HAR involved
Recurring Congestion Clear	Delay Cleared	Normal Traffic Flow	Variable	Accuracy of detector information	Accuracy of information from detectors, response time of FMS
SPECIAL EVENT LOG					
Special Event Scheduled to Begin	Special Event Log Initiated	Special Event Notification	3-5 minutes	Accuracy of information	Accuracy of plan, # of DMS/HAR involved, response time of FMS
Special Event Expires	Clear messages from DMS/HAR	Terminate Special Event Plan	2 minutes	Message arbitration handled correctly	# of DMS/HAR involved, response time of FMS
WEATHER ADVISORY LOG					
Weather Advisory Received	Weather Advisory Log Initiated	Weather Advisory Notification	3-5 minutes	Accuracy of information	
Weather Advisory Changes	Weather Advisory Log Updated	Update Weather Advisory	2-4 minutes	Accuracy of information	Accuracy of information
Select messages and DMS/HAR devices	Display/broadcast messages	Provide Traveler Information	3-5 minutes	Message arbitration handled correctly	# of DMS/HAR involved, response time of FMS

Event	Result	Process Thread	Time	Quality	Variables
Weather Advisory Expires	Close Log and clear messages from DMS/HAR	Terminate Weather Advisory Plan	2 minutes	Message arbitration handled correctly	# of DMS/HAR involved, response time of FMS
WEATHER SENSOR LOG					
Weather Sensors Detect Hazardous Conditions	Weather Sensor Log Initiated	Activate Weather Sensor Plan	3-5 minutes	Accuracy of information	Accuracy of information, # of DMS/HAR involved, response time of FMS
Weather Sensor Detect Conditions Return to Normal State	Clear messages from DMS/HAR	Weather Sensor Signs Terminated	2 minutes	Message arbitration handled correctly	# of DMS/HAR involved, response time of FMS
SAFETY MESSAGE LOG					
Safety Message Log Initiation	Safety Messages Prepared	Post Safety Message	3-5 minutes	Accuracy of information input	Accuracy of information, # of DMS/HAR involved, response time of FMS
Restore Messages to Queue	Safety Messages Cleared	Clear Safety Message	2 minutes	Message arbitration handled correctly	# of DMS/HAR involved, response time of FMS

Figure 1-18. CHART Threads Performance Objectives

Lacking best practices information and historical data, the 'faster is better' rule will be applied to process and application design efforts to ensure that processes and applications reflect the most efficient manner for accomplishing all given processes and tasks. Rather than having measurable objectives to strive for, CHART will concentrate on process designs that 1) automate as much as possible, 2) application designs that are intelligent and minimize user interaction, and 3) technology architectures that provide the most throughputs for the money being invested.

Application performance goals will be defined in the Application Design phase based on best practices for computer systems, thereby giving application designers and acceptors the necessary baseline to evaluate the performance of the system from a technical perspective.

Guiding principles, constraints and assumptions support best efforts to design an efficient system from a process and application design perspective, and will be the performance objectives for this system.

1.6.2 CHART II Activities Performance Model

The BAA process identifies the various business activities performed by the CHART organization and business processes designed to capture information about each of these activities. It is desirable in business to measure and understand the volume of activities conducted by a business area. This volumetric measurement of activities provides information by which to determine workloads and resource requirements. Various views of these volumetric measurements can be used to determine peak periods of workloads, variances over time, etc. The following table identifies the types of volumetric measurements that would be useful in managing the business area and are to be obtainable from the CHART II Archive data.

TYPE OF VOLUMETRIC MEASUREMENT	PURPOSE OF MEASUREMENT
Count of activity logs	Rough measurement of workload
Count of activity logs by operation center	Measurement of workload by operation center
Count by activity type over time	Measurement of increase/decrease in particular activities
Count of activity type by roadway	Trends by roadway
Count of activity type by roadway over time	Time-phased trends by roadway
Count of activity type by link	Trends by link
Count of activity type by link over time	Time-phased trends by link

1.6.3 Public Perception

It is important in business to obtain feedback from customers relative to the products and services being offered. This feedback provides information to the business for purposes of improving those products and services, and provides a basis for reorienting the business for the future to meet expected customer demands.

CHART is a service-oriented business, providing on-the-road assistance for accidents, disabled vehicles, traveler information on signs and radios. It also provides public access to camera feeds through the CHART web site, provides current incident information through its Incident Exchange Database, and provides statistic traffic flow and CHART operations information through its Archive database. In order to increase CHART's effectiveness as a business, it should be determined how the public and users perceive the usefulness of these services, if they are aware of the availability of these services, and their reactions to the quality of these services.

These measurements are typically gathered through surveys. Three categories of individuals (or locations) to be surveyed have been identified which may provide useful feedback to CHART management.

Disabled Motorists — When providing roadside assistance, CHART vehicle drivers give out card surveys for travelers to rate the service. These surveys usually have a very positive feedback because these individuals were the direct recipients of needed assistance. Though the responses are predictable, these surveys should continue to identify any exceptions.

Web Site Surveys — Surveys could be made available on the CHART web site, which would be a different sampling of the public though slanted to individuals aware of some of the CHART services. Responses as to quality, timeliness, adequacy, and speed of information could be informative in determining where to dedicate resources for Web Page designs or more robust services.

Motor Vehicle Administration — Requesting customers at Motor Vehicle Administration to fill out a survey should provide a larger cross section sampling of the public, at least representing possible individuals with no knowledge of CHART. These surveys should attempt to measure

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public awareness of CHART and CHART services, and obtain geographic feedback as to areas more or less aware of CHART services and, therefore, more or less inclined to utilize those services. Obtaining public input as to frequency or future intention of use of types of services may be used to plan future upgrades in services and systems for specific geographical areas.

1.7 CHART II Release Strategy

Consistent with the Catalyst methodology, it is proposed to build and deploy the CHART II system in a series of releases and builds. As opposed to the "big-bang" approach, the multiple release strategy is done to divide the system into manageable sized pieces that will:

1. provide functionality to SHA in a sequence consistent with their operational needs

2. lessen the impact on the client organization to absorb training and utilize the new applications

3. provide reasonably sized sets of code for development, testing, and documentation

4. allow for iterative repairs and design improvements over multiple releases

A release strategy was developed early in the BAA process to sequence the process design efforts and allow an early start on the development of the first release. This strategy consisted of four releases and was defined per the following table.

RELEASE	SUBJECT AREA	FUNCTIONALITY
Release 1	Administration	
		Login
		Application Access Control
	Navigator	
		Status of Devices
		Message Library
		Device Control
	Operator Communications Log	
		Manual incident data entry
		Operator selection of incident response actions
	Incident Management (Basic)	
	DMS	
	HAR	
	SHAZAM	
	Logging System Failures and Actions	
Release 2	GUI	
		Device Control
		Device Status

RELEASE	SUBJECT AREA	FUNCTIONALITY
		Incident
		Detection (indicate congestion)
	Incident Management (Advanced – Lane Level)	
	Reports	
	FAX	
	Paging	
	Legacy Systems Interface	
		Weather
		EORS
		IEN
		PIM
	AVCM	
	WWW	
Release 3	Incident Response	
		Rules Based (automated)
		FITM Plans
		Signal Controls
	Archive	(moved to Release 4)
	AVL	
	Maintenance	
	Legacy Systems Interface (remaining)	
Release 4	Other Agencies Requirements	Interfaces to Montgomery County and VDOT
	Archive Reports	
	Simulation	

Upon completion of the BAA process re-engineering activities, the release strategy was reviewed in light of the defined processes and each process was assigned to one or more releases to further define the release strategy. The following table shows the relationship between processes and releases. Those processes indicated as being developed in multiple releases identify an initial development of the process and iterations of those processes to incorporate other capabilities of the system available in the next release.

Further breakdown of the releases into builds will occur during the design and development phase of the project.

				1	2	3	4
SECURITY AND OPERATIONAL CONTROL							
System Administration							
	a		Maintain Users	X	X		
	b		Maintain Roles	X	X		
	c		Maintain Functional Rights	X	X		
	d		Maintain Functional Responsibilities	X	X		
	e		Maintain Geographic Responsibility		X		
	f		Maintain Operations Center and AOR	X	X		
Operational Control							
	a		Maintain Center Notepad		X		
	b		User Logon	X	X		
	c		View Center Situation		X		
	d		Maintain User Preferences		X		
	e		Maintain Operator's Notepad		X		
	f		Perform CHART Chat		X		
	g		Logout	X	X		
	h		Change User	X	X		
	i		Transfer Resources	X			
	j		Respond to Request to Transfer Resources	X			
Configuration Processes							
	a		Maintain System Parameters	X	X	X	X
	b		Maintain Links		X		
FITM Plans							
	a		Maintain FITM Plans			X	
Map Configuration							
	a		Update MDOT GIS Map Data		X		
SYSTEM CONFIGURATION AND STATUS							
Components							
	a		Maintain Component Configuration	X	X	X	
	b		Log System Failures	X	X	X	
Devices							
	a		Maintain Device Configuration	X	X	X	
	b		Set Device Online	X	X	X	
	c		Set Device Offline	X	X	X	
	d		Set Device to Maintenance Mode	X	X	X	
	e		Handle DMS and HAR Polling Results	X			
	f		Respond to Device Failure Alerts	X	X	X	
INCIDENT/EVENT MANAGEMENT							
Logs							
	a		Log Communications Log	X			
	b		Log Action Log	X	X	X	
	c		Log Disabled Vehicle Log	X		X	
	d		Log Incident Log	X	X	X	

Release #4
Release #3
Release #2
Release #1

Figure 1-19. Processes by Release Matrix – Page 1/4

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			1	2	3	4
	e	View Historical vs. Current		X		
	f	Log Congestion Log	X	X	X	
	g	Log Recurring Congestion Log	X	X	X	
	h	Log Special Event Log	X	X	X	
	i	Log Weather Advisory Log	X	X		
	j	Log Weather Sensor Log	X	X		
	k	Log Safety Message Log	X	X	X	
	l	View Log	X	X	X	
	m	Close Log	X	X	X	
Location Navigation						
	a	Maintain Location Navigation Data		X		
	b	Activate Location Navigator		X		
Queues						
	a	Calculate Queue Length	X	X		
Notification						
	a	Maintain Notification List		X		
	b	Perform Notificaiton		X		
SHARED RESOURCE MANAGEMENT						
DMS/HAR Common Processes						
	a	Maintain Acceptable Word Dictionary (Spell Check)	X			
	b	Maintain Unacceptable Word Dictionary	X			
	c	Perform Responsibility Reminder		X		
	d	Respond to Responsibility Reminder Alert		X		
DMS Processes						
	a	Maintain DMS Message Library	X			
	b	DMS – Add a Message	X	X		
	c	DMS – Remove a Message	X	X		
	d	DMS – Arbitrate Message Queue		X		
	e	DMS – Evaluate Queue		X		
	f	DMS – Send a Message	X	X		
	g	DMS – Blank a Sign	X			
	h	DMS - Reset	X			
	i	DMS – Restore Message	X	X		
	j	DMS- Override Queue		X		
HAR Processes						
	a	Maintain HAR Message Library	X			
	b	HAR – Add a Message	X	X		
	c	HAR – Remove a Message	X	X		
	d	HAR – Arbitrate Message Queue		X		
	e	HAR – Evaluate Queue		X		
	f	HAR – Broadcast a Message	X	X		
	g	HAR – Broadcast Default Message	X	X		
	h	HAR – Set Shazam On/Off	X	X		

Release #4
Release #3
Release #2
Release #1

Figure 1-20. Processes by Release Matrix – Page 2/4

		Release #1	Release #2	Release #3	Release #4
i	HAR – Update Default Message	X			
j	HAR – Send Maintenance Command	X	X		
k	HAR – Restore Message	X	X		
l	HAR - Override Queue		X		
AVCM					
a	Maintain Wall Monitor Configuration		X		
b	Control Wall Monitor Assignment		X		
c	Maintain CCTV Presets		X		
d	Refresh Default AVCM Presets		X		
e	Maintain Tours		X		
f	Activate Tour		X		
g	Control Camera		X		
Detectors					
a	Handle Polled Detector Data		X		
b	Handle Detector Rules		X		
c	Generate Congestion Response		X		
d	Respond to Congestion Alert		X		
e	Generate Incident Response		X		
f	Respond to Incident Alert		X		
g	Activate Response Plan		X		
Equipment					
a	Maintain Equipment Inventory			X	
b	Maintain Equipment Status			X	
c	Alert For Delinquent Equipment Status			X	
d	Respond to Delinquent Equipment Status Alert			X	
Signals					
a	Handle Signal Polling Data			X	
b	Respond to Exceeded Signal Threshold Alert			X	
c	Download Signal Data			X	
AVL					
a	Handle AVL Polling Results			X	
b	Perform AVL Function Processing			X	
c	Process AVL In/Out of Service Message			X	
d	Process AVL Mayday Message			X	
e	Process AVL Arrival On-Scene Message			X	
f	Process AVL Assist Disabled Vehicle Message			X	
g	Process AVL Assist Disabled CHART Vehicle Message			X	
h	Process AVL Available Message			X	
i	Respond to AVL Alerts			X	
j	Respond to Mayday Alert from AVL			X	
k	Respond to Arrival On-Scene Alert from AVL			X	
l	Respond to Disabled Vehicle Alert from AVL			X	
ALERTS					

Figure 1-21. Processes by Release Matrix – Page 3/4

			1	2	3	4
	a	Send Manual Alert		X	X	
	b	Send Alert		X	X	
	c	Escalate Alert		X	X	
PLANS						
	a	Maintain Plans	X	X	X	X
	b	Activate Plan	X	X	X	X
	c	Deactivate Plan		X	X	X
SCHEDULED EVENTS						
	a	Maintain Scheduled Events		X	X	X
	b	Process Scheduled Events Start		X	X	X
	c	Process Scheduled Events End		X	X	X
EORS INTERFACE						
Construction						
	a	Download EORS Permits		X		
	b	Activate EORS Icon On Map		X		
	c	Activate EOR Permit		X		
Snow Emergency						
	a	Maintain Snow Emergency Declaration		X		
Phone Book						
	a	Access Phone Book		X		
WEATHER SUPPORT						
National Weather Service						
	a	View National Weather Service Data		X		
	b	Process Weather Alerts From The NWS		X		
	c	Respond to National Weather Service Alert		X		
	d	Fax Weather Report		X		
SCAN						
	a	Handle Weather Sensor Data		X		
	b	Generate Weather Sensor Response		X		
	c	Respond to Weather Sensor Alert		X		
ARCHIVING AND REPORTS						
Archiving						
	a	Archive Update - Add	X	X	X	X
	b	Archive Update - Update Log Data	X	X	X	X
	c	Real Time System Update - Delete	X	X	X	X
Reports						
	a	Operational Reports	X	X	X	X
	b	Reports from Archive			X	X
Other Agencies						
	a	Montgomery County				X
	b	VDOT				X
	c	PIM				X
	d	TRANSCOM				X
	e	911 Centers				X

Figure 1-22. Processes by Release Matrix – Page 4/4

2 Business Process Model View

This section presents various model views of the Business Processes derived from CHART II visioning and process design workshops. The Direction Model provides the principles, constraints and assumptions that guide the design of business processes, while the Conceptual Model provides the specifics of business processes defined and derived as a result of the workshops.

2.1 Business Process Direction Model

This model shows what business process principles, constraints, and assumptions impact the project.

2.1.1 Business Process Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The following table shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶ Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷ To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸ Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	Attempt to improve processes through automation whenever possible
❶	Minimize operator options
Constraints	
	None
Assumptions	
	None

2.2 Conceptual Business Process Model

The Conceptual Business Process Model provides process decomposition of the business processes within the scope of the business area under investigation. It also presents process dynamics, *that is,* how lower-level business processes interrelate, or flow, to implement a higher-level process.

2.2.1 Implementation Constraints and Assumptions

Usually a conceptual Business Process Model reflects business activities and tries to avoid any extensive discussion of the implementation of any automated processes. Due to the background of the CHART II project, an implementation approach has already been selected based on the prototype applications submitted during the contract award phase. Having an implementation approach already specified forces certain constraints in the design of business processes. To minimize these constraints, the business processes recognize and make reference to only two high level aspects of the implementation approach – the Navigator and the Map. The following identifies the assumptions about the implementation approach as affected by the business processes.

- Navigator – the Navigator is a directory-type text display to the operator. This display identifies selectable components that the operator may select as required to utilize a component, device, event, etc.; or to obtain current status information about the item selected.
- Map – the Map is a geographical display of roadways, devices, incidents, etc. to the operator. This display is comprised of map layers, each layer related to a different type of device or event. Layers display icons or area shadings to represent locations of the topic of the layer (DMS devices, snow emergency areas, incident locations, EORS permit locations, etc.). Operators select which layers are displayed over the Map based on the job they are performing.

Some CHART II business processes identify relationships with the Navigator and/or the Map (usually to provide data to them) to indicate that the displays are to be updated and refreshed for user viewing, or that status information is updated and available if the user should select that item. In and of themselves, the Navigator and the Map are not business processes and as such no process flows will be found in this section for them.

2.2.2 Business Process Hierarchy

The Business Process Hierarchy is a schematic representation of the results of process decomposition. In the Construction and Deployment Phase, the decomposition will be taken to the elementary business process (EBP) level.

The Business Process Hierarchy shown below indicates the division of processes by major process groups, and the processes identified in the process design workshops (or derived as the result of analysis). These process groups and processes are organized in a *process orientation*. This orientation disregards the roles that perform the processes in order to represent the business process flow of traffic management as performed by CHART.

Figure 2-1. CHART II Business Process Hierarchy – Part 1 of 2

CHART II

INCIDENT/ EVENT MANAGEMENT

Logs
- Log Communications Log
- Log Action Log
- Log Disabled Vehicle Log
- Log Incident Log
  - View Historical vs. Current
- Log Congestion Log
- Log Recurring Congestion Log
- Log Special Event Log
- Log Weather Advisory Log
- Log Weather Sensor Log
- Log Safety Message Log
- View Log
- Close Log

Location Navigation
- Maint Location Navigation Data
- Activate Location Navigator

Queues
- Calculate Queue Length

Notification
- Maint Notification List
- Perform Notification

ALERTS
- Send Manual Alert
- Send Alert
- Escalate Alert

PLANS
- Maintain Plans
- Activate Plan
- Deactivate Plan

SCHEDULED EVENTS
- Maint Scheduled Events
- Process Scheduled Events Start
- Process Scheduled Events End

EORS INTERFACE

Construction
- Download EORS Permits
- Activate EORS Icons on Map
- Activate EOR Permit

Snow Emergency
- Maint Snow Emergency Declaration

Phone Book
- Access Phone Book

WEATHER SUPPORT

National Weather Service
- View National Weather Service Data
- Process Weather Alerts from the NWS
- Respond to NWS Alert
- Fax Weather Report

SCAN
- Handle Weather Sensor Data
- Generate Weather Sensor Response
- Respond to Weather Sensor Alert

ARCHIVING AND REPORTS

Archiving
- Archive Update - Add
- Archive Update - Update Log Data
- Real Time System Update - Delete

Reports
- Operational Reports
- Reports from Archive

Figure 2-2. CHART II Business Process Hierarchy - Part 2 of 2

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2.2.3 Business Processes by Type

CHART processes have been grouped into four types of processes: *System Administration, Center Administration, Operational,* and *Custodial*.

Administrative processes are those processes that configure and control the system functionality. Administrative processes are divided into System Administration and Center Administration to identify the respective level of configuration and control, and the roles that are responsible for executing these processes.

Operational processes are those processes that require operator interaction to initiate or perform the process.

Custodial processes are repetitive, scheduled system processes that do not require operator control or presence for these processes to be executed.

The following matrix identifies each process and the process type assigned to each process.

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			1	2	3	4
SECURITY AND OPERATIONAL CONTROL						
System Administration						
	a	Maintain Users	X			
	b	Maintain Roles	X			
	c	Maintain Functional Rights	X			
	d	Maintain Functional Responsibilities	X			
	e	Maintain Geographic Responsibility	X			
	f	Maintain Operations Center and AOR	X			
Operational Control						
	a	Maintain Center Notepad		X		
	b	User Logon			X	
	c	View Center Situation			X	
	d	Maintain User Preferences			X	
	e	Maintain Operator's Notepad			X	
	f	Perform CHART Chat			X	
	g	Logout			X	
	h	Change User			X	
	i	Transfer Resources			X	
	j	Respond to Request to Transfer Resources			X	
Configuration Processes						
	a	Maintain System Parameters	X			
	b	Maintain Links	X			
FITM Plans						
	a	Maintain FITM Plans	X			
Map Configuration						
	a	Update MDOT GIS Map Data	X			
SYSTEM CONFIGURATION AND STATUS						
Components						
	a	Maintain Component Configuration	X			
	b	Log System Failures				X
Devices						
	a	Maintain Device Configuration	X			
	b	Set Device Online			X	
	c	Set Device Offline			X	
	d	Set Device to Maintenance Mode			X	
	e	Handle DMS and HAR Polling Results				X
	f	Respond to Device Failure Alerts			X	
INCIDENT/EVENT MANAGEMENT						
Logs						
	a	Log Communications Log			X	
	b	Log Action Log			X	
	c	Log Disabled Vehicle Log			X	

Column headers (top, angled): 1 = System Administration, 2 = Center Administration, 3 = Operational, 4 = Custodial

Figure 2-3. Process by Process Type Matrix, Part 1/4

				System Administration (1)	Center Administration (2)	Operational (3)	Custodial (4)
		d	Log Incident Log			X	X
		e	View Historical vs. Current			X	
		f	Log Congestion Log			X	X
		g	Log Recurring Congestion Log			X	X
		h	Log Special Event Log			X	X
		i	Log Weather Advisory Log			X	X
		j	Log Weather Sensor Log			X	X
		k	Log Safety Message Log			X	X
		l	View Log			X	
		m	Close Log			X	X
	Location Navigation						
		a	Maintain Location Navigation Data	X			
		b	Activate Location Navigator			X	
	Queues						
		a	Calculate Queue Length			X	X
	Notification						
		a	Maintain Notification List	X			
		b	Perform Notificaiton			X	X
SHARED RESOURCE MANAGEMENT							
	DMS/HAR Common Processes						
		a	Maintain Acceptable Word Dictionary	X			
		b	Maintain Unacceptable Word Dictionary	X			
		c	Perform Responsibility Reminder				X
		d	Respond to Responsibility Reminder Alert			X	
	DMS Processes						
		a	Maintain DMS Message Library	X			
		b	DMS – Add a Message			X	X
		c	DMS – Remove a Message			X	X
		d	DMS – Arbitrate Message Queue				X
		e	DMS – Evaluate Queue				X
		f	DMS – Send a Message				X
		g	DMS – Blank a Sign				X
		h	DMS - Reset			X	X
		i	DMS – Restore Message				X
		j	DMS- Override Queue			X	
	HAR Processes						
		a	Maintain HAR Message Library	X			
		b	HAR – Add a Message			X	X
		c	HAR – Remove a Message			X	X
		d	HAR – Arbitrate Message Queue				X
		e	HAR – Evaluate Queue				X
		f	HAR – Broadcast a Message				X

Figure 2-4. Process by Process Type Matrix, Part 2/4

			System Administration (1)	Center Administration (2)	Operational (3)	Custodial (4)
	g	HAR – Broadcast Default Message				X
	h	HAR – Set Shazam On/Off				X
	i	HAR – Update Default Message			X	
	j	HAR – Send Maintenance Command			X	
	k	HAR – Restore Message				X
	l	HAR - Override Queue			X	
AVCM						
	a	Maintain Wall Monitor Configuration	X			
	b	Control Wall Monitor Assignment			X	
	c	Maintain CCTV Presets	X			
	d	Refresh Default AVCM Presets				X
	e	Maintain Tours	X			
	f	Activate Tour			X	X
	g	Control Camera			X	
Detectors						
	a	Handle Polled Detector Data				X
	b	Handle Detector Rules				X
	c	Generate Congestion Response				X
	d	Respond to Congestion Alert			X	
	e	Generate Incident Response				X
	f	Respond to Incident Alert			X	
	g	Activate Response Plan				X
Equipment						
	a	Maintain Equipment Inventory	X			
	b	Maintain Equipment Status			X	
	c	Alert For Delinquent Equipment Status				X
	d	Respond to Delinquent Equipment Status Alert			x	
Signals						
	a	Handle Signal Polling Data				x
	b	Respond to Exceeded Signal Threshold Alert			x	
	c	Download Signal Data				x
AVL						
	a	Handle AVL Polling Results				x
	b	Perform AVL Function Processing				x
	c	Process AVL In/Out of Service Message				x
	d	Process AVL Mayday Message				x
	e	Process AVL Arrival On-Scene Message				x
	f	Process AVL Assist Disabled Vehicle Message				x
	g	Process AVL Assist Disabled CHART Vehicle Message				x
	h	Process AVL Available Message				x
	i	Respond to AVL Alerts				
	j	Respond to Mayday Alert from AVL			x	
	k	Respond to Arrival On-Scene Alert from AVL			x	

Figure 2-5. Process by Process Type Matrix, Part 3/4

			1	2	3	4
l		Respond to Disabled Vehicle Alert from AVL			x	
ALERTS						
a		Send Manual Alert			X	
b		Send Alert				X
c		Escalate Alert				X
PLANS						
a		Maintain Plans	X			
b		Activate Plan			X	X
c		Deactivate Plan			X	X
SCHEDULED EVENTS						
a		Maintain Scheduled Events	X			
b		Process Scheduled Events Start				X
c		Process Scheduled Events End				X
EORS INTERFACE						
Construction						
a		Download EORS Permits				X
b		Activate EORS Icon On Map				X
c		Activate EOR Permit			X	
Snow Emergency						
a		Maintain Snow Emergency Declaration				X
Phone Book						
a		Access Phone Book			X	
WEATHER SUPPORT						
National Weather Service						
a		View National Weather Service Data			X	
b		Process Weather Alerts From The NWS				X
c		Respond to National Weather Service Alert			X	
d		Fax Weather Report				x
SCAN						
a		Handle Weather Sensor Data				X
b		Generate Weather Sensor Response				X
c		Respond to Weather Sensor Alert			X	
ARCHIVING AND REPORTS						
Archiving						
a		Archive Update - Add				X
b		Archive Update - Update Log Data				X
c		Real Time System Update - Delete				X
Reports						
a		Operational Reports			X	X
b		Reports from Archive			X	X

Column headers (top, spanning diagonally): Custodial, Operational, Center Administration, System Administration

Figure 2-6. Process by Process Type Matrix, Part 4/4

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2.2.4 Business Process Flows / Data Flow Diagrams

This section of the report presents the data flow diagrams from the BusinessTeam analysis tool. The following data flow diagrams are organized as illustrated in Figure 2-1. CHART II Business Process Hierarchy.

The CHART II processes presented in this section identify several processes and data stores that might logically belong to other applications, either in part or in whole. Some configuration data and system parameter data might belong to the FMS application or to the AVCM application. For the purposes of these process flows, and to provide completeness of the process analysis, it has been assumed that FMS and AVCM will share these data stores – or the interfaces between these separately developed applications will be coordinated during the application design phase of this project.

2.2.4.1 Security and Operational Control

The Security and Operational Control processes include all those processes necessary to define, setup and control the security aspects and architectural parameters for the CHART II system. These processes are divided into groups related to *System Administration, Operational Control, Configuration Processes, FITM plan maintenance,* and *Map Configuration.* Figure 2-7. Security and Operational Control identifies the individual processes within each group.
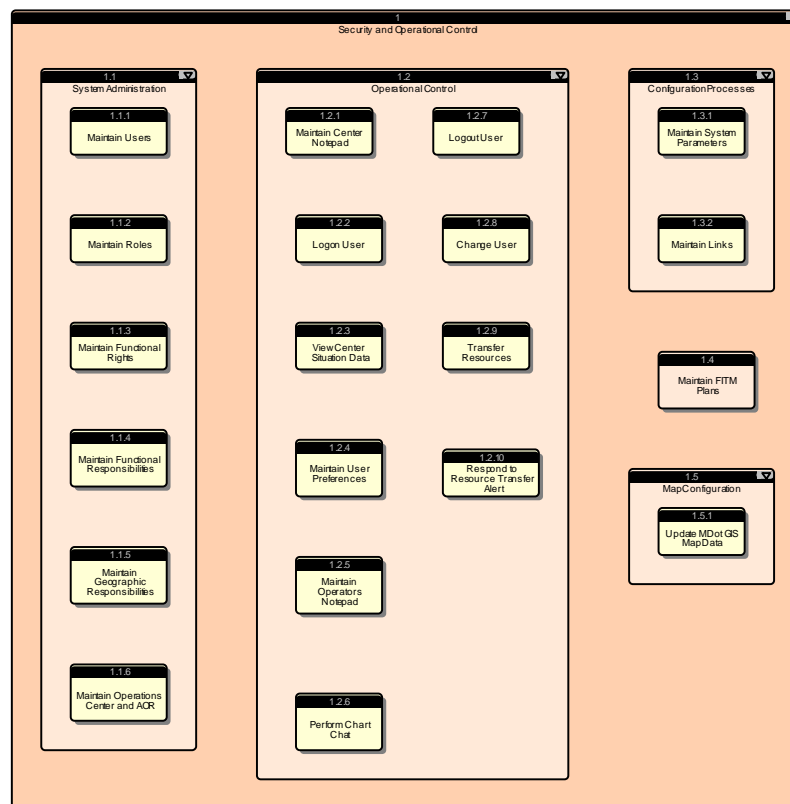
Figure 2-7. Security and Operational Control

2.2.4.1.1 System Administration

The System Administration process group identifies the required processes to establish the users and the centers (locations) of the system.

Users are defined to the system by both their identity *and* the functional capabilities that are granted to them. Access to the functional capabilities of the system is controlled through the definition of the system's functional capabilities, the grouping of functional capabilities into Roles, and then the assignment of Role(s) to users.

Centers are the physical or logical organizational entities supported by the system. Centers are defined to the system by their identity and hierarchical relationship to other centers, their functional responsibilities, and their geographical area of responsibility. Functional Responsibilities define the system capabilities that centers may perform, and they define the types of Alerts that are generated by the system (similar to the relationship between users and Functional Rights). Geographical Area of Responsibility is the geographical area definitions that are assigned to centers to define the area from which they are to receive Alerts. Establishment of a center includes defining the center by its name and location, its relationship to other centers in the hierarchy of responsibilities, the assignment of Functional Responsibilities (or groups of Functional Responsibilities), and the assignment of any Geographical Area of Responsibility.

The conceptual objective of CHART is to allow the maximum amount of flexibility in establishing relationships between users and centers, while still maintaining the specific mission support capabilities of the individual centers. CHART is intended to support these three User-to-Center scenarios:

- Users may be trained to support more than one type of center (for example; TOC and Maintenance Shop) and should be expected to be able to work at either as required.

- Users may be temporarily assigned to any one of several similar centers (*for example,* from TOC3 to the SOC).

- Users may need to logon from a different center to perform work for their assigned center (*for example,* while at the SOC, the Maintenance Shop user may wish to logon and check the current alerts for his/her shop).

To achieve the objective flexibility, the processes and architecture need to support the following relationships between users, centers, and the CHART workstations:

- Users are defined as being granted specific Functional Rights and related to specific centers for which they might be assigned. As in the first scenario above, a user may be granted the necessary functional rights to perform the duties of an operator at both a TOC and a Maintenance Shop, and then the user is related to TOC3 and the Hanover Maintenance Shop.

- Centers are defined as being responsible for performing specific system functional responsibilities as necessary to support their mission requirements. It is expected that a TOC center would have a more extensive set of functional responsibilities than a Maintenance Shop center. Should the user with functional rights granted to perform the duties of an operator at *both* a TOC and a Maintenance Shop log onto the system and identify himself/herself as relating the session with the Maintenance Shop, he/she will

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only be allowed to perform those assigned functional rights that match with the functional responsibilities specified for the Maintenance Shop center.

- Workstations were defined initially as being physically related to the location (center) where they are installed, however current thinking now is that workstations will need to be dynamically related to centers as designated for the user of the workstation. To support the three scenarios described above, the system will need to determine which centers have been related to the user. If *more than one* have been designated, the system must have the user indicate to which center this session is to be related. If it's assumed in the third scenario above that this Maintenance Shop user is only related to one center (his/her Maintenance Shop), the user should not have to indicate the center to be related in this session. For the duration of the session, the workstation needs to function as a part of the center indicated, interfacing with appropriate distributed databases, receiving Alerts for the center as appropriate, and adhering to the conditions of the Logout process.

Implementation Considerations: the hierarchical relationship between centers defines the routing of responsibility for escalation of Alerts when lower level organizations in the hierarchy do not respond to the Alerts. For purposes of this BAA, it is assumed that this hierarchical relationship between centers is an attribute of the definition of a center, and no specific process or data store is defined for this relationship. Since a multitude of implementation options is possible, this needs to be reviewed during the Application Design phase. An initial schematic of the center hierarchy is available in section **4.2.3**, **Location Hierarchy** to assist in this analysis.

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2.2.4.1.1.1 Maintain Users

The Maintain Users process maintains a table of values identifying recognized CHART II users, and provides the capabilities to maintain the set of Roles and centers assigned to these users.

Maintain Users - 9/17/99
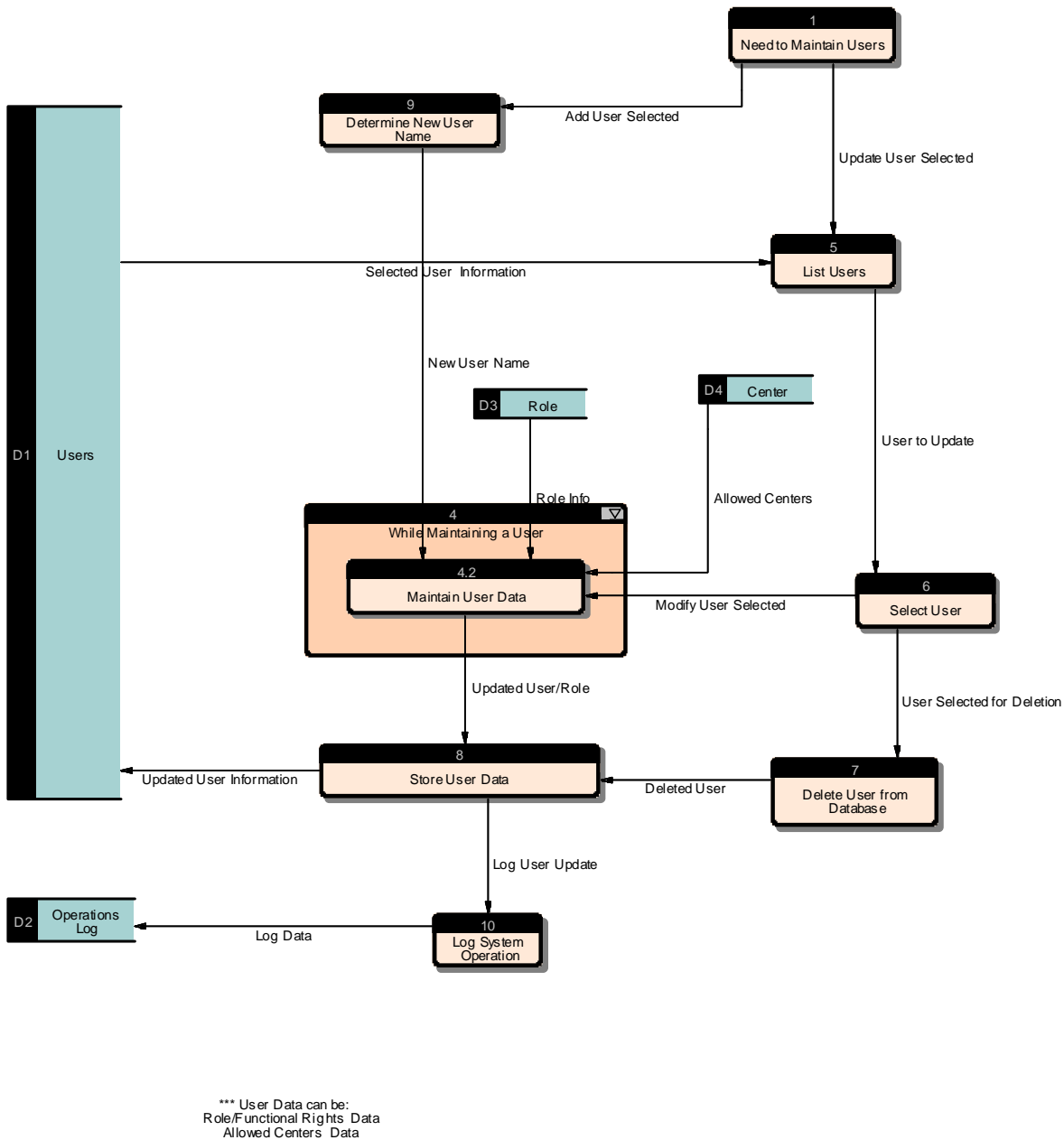
Figure 2-8. Maintain User

2.2.4.1.1.2 Maintain Roles

The Maintain Roles process maintains the table of values designating the various security roles defined for the system. This process also provides the capabilities for maintaining the relation to the set of Functional Rights identifying the system capabilities associated with each Role.

In the process design workshops, types of roles needed in the system were defined as:

- Full – Create/Edit Message content (DMS, HAR stored messages)

- Partial – Send message from library

- Area of Responsibility – Subset of Full/Partial

- View Only

- Admin – System administration privileges

Each role may have several levels of privileges. The discussion by the group led to the determination of three administration levels. View and Partial roles will also be broken down further as shown in the list of privileges associated with the various users of the system. It was determined that the Media would not have the privilege of viewing full incident reports. Partial will be broken down further by the type of device to be accessed, as shown in the Signal Ops category.

Admin levels:

- Parameters (colors, etc.)

- User/device admin

- Functional (backup/restore)

Examples of Organizational roles and the type of security role expected to be related:

- Highway Operations Technician (HOT) – Full

- Police – Partial

- System Administrator – Admin

- Signal Ops – Partial for selected devices only

- Shop Maintenance – Partial

- Device Maintenance – Partial

- Media – Limited View only with filtered incident reports

- Government – Partial

- SHA Management – View only

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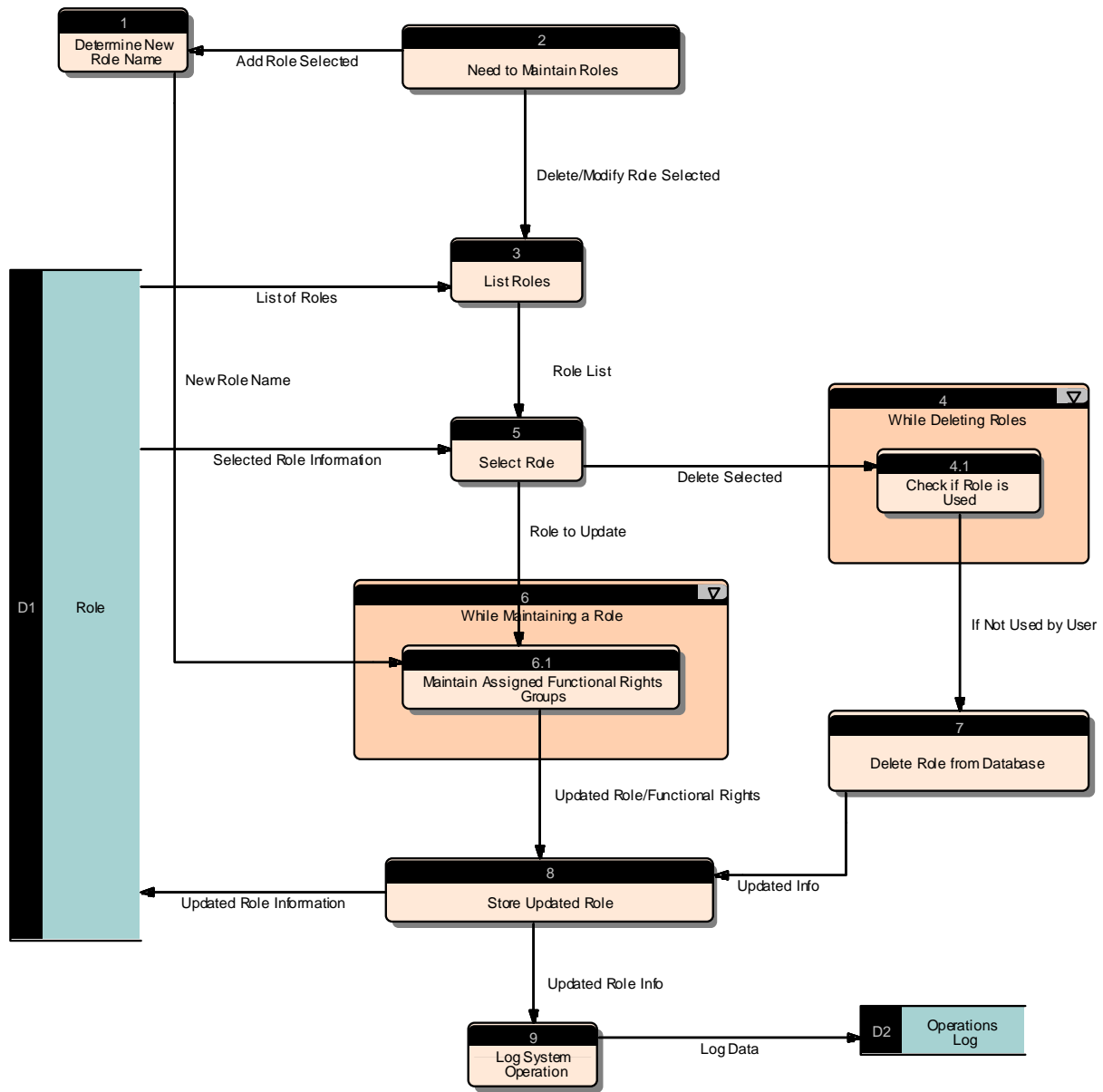
Figure 2-9. Maintain Roles

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2.2.4.1.1.3   Maintain Functional Rights

The Maintain Functional Rights process maintains the table of values that designates the functional capabilities of the system that may be assigned to specific Roles and subsequently assigned to users.

Implementation Considerations: These Functional Rights need to be defined during the Application Design phase to ensure the appropriate level of functional capability is designated. For example, the ability to View an Incident Log needs to be divided into two Functional Rights – one for Operators to have the capability to view the raw data, and one for external users who will have the capability to view a filtered set of data. However implemented, it must be recognized that these are two distinct Functional Rights.

CHART II Business Area Architecture Report   54   August 23, 2000
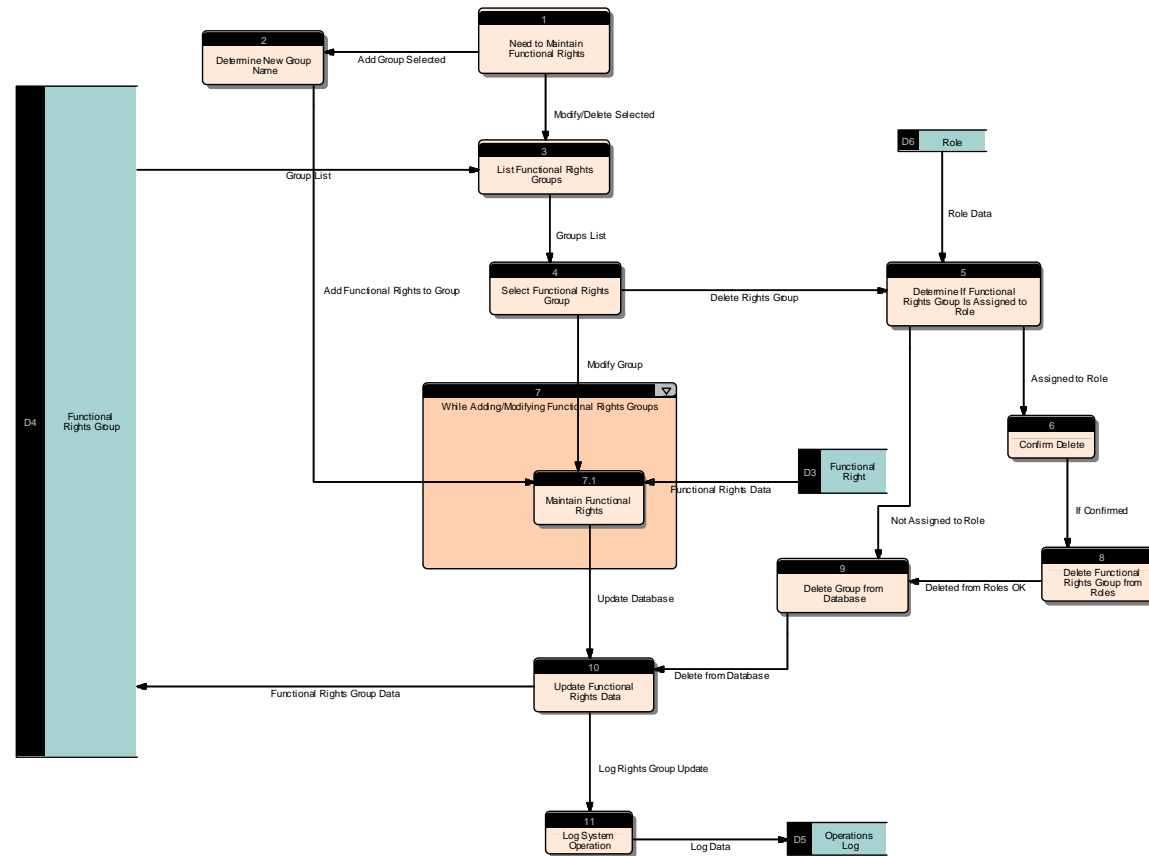
Figure 2-10. Maintain Functional Rights

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2.2.4.1.1.4 Maintain Functional Responsibilities and Alert Types

The Maintain Functional Responsibilities and Alert Types process maintains the table of values that designates the functional capabilities of the system that may be assigned to specific centers.

Implementation Considerations: These Functional Responsibilities and Alert Types define the system capabilities for centers and logically may be at a different level of specificity than the Functional Rights assigned to users. For example, specifying a Functional Responsibility for Action Logs may be sufficient to indicate the related Maintenance Shop center will have access to Action Logs; whereas Functional Rights assigned to users at the Maintenance Shop will limit their Functional Rights to Viewing and Closing of the Action Logs, but not the creation of Action Logs.

CHART II Business Area Architecture Report   56   August 23, 2000
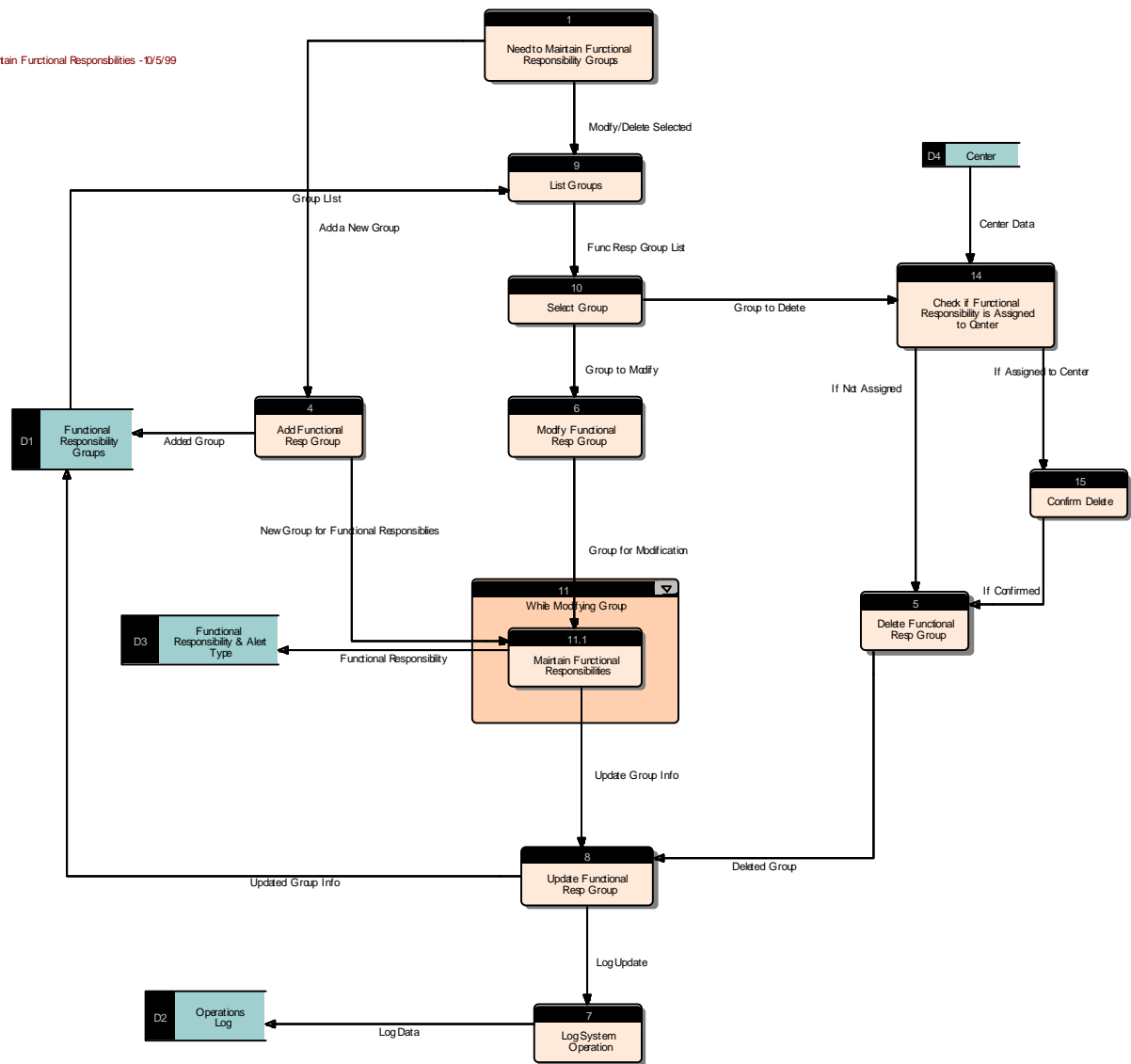
Figure 2-11. Maintain Functional Responsibilities

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2.2.4.1.1.5 Maintain Geographic Responsibility

The Maintain Geographic Responsibility process maintains the table of geographic boundaries used to designate the geographic areas of responsibility for the centers.

Geographic areas of responsibility are expected to be as large as the entire state and as small as part of a county. Different geographic areas may overlap other geographic areas within the table of defined geographic areas, with the expectation that they will be related to different types of centers. For example, Maintenance Shops have relatively small areas of responsibilities as compared to TOCs, and an area of responsibility for a specific Maintenance Shop may cross the boundaries of the areas of responsibility for two TOCs.

Once related to a center, these geographic areas of responsibilities (along with assigned Functional Responsibilities) are used to identify the center to receive specific types of Alerts for specific types of devices within the area. For example, a specific Weather Station will fall within the geographic area of responsibility of a TOC for purposes of weather related Alerts, and will fall within the geographic area of responsibility of a Radio Maintenance Shop for purposes of device failure Alerts.
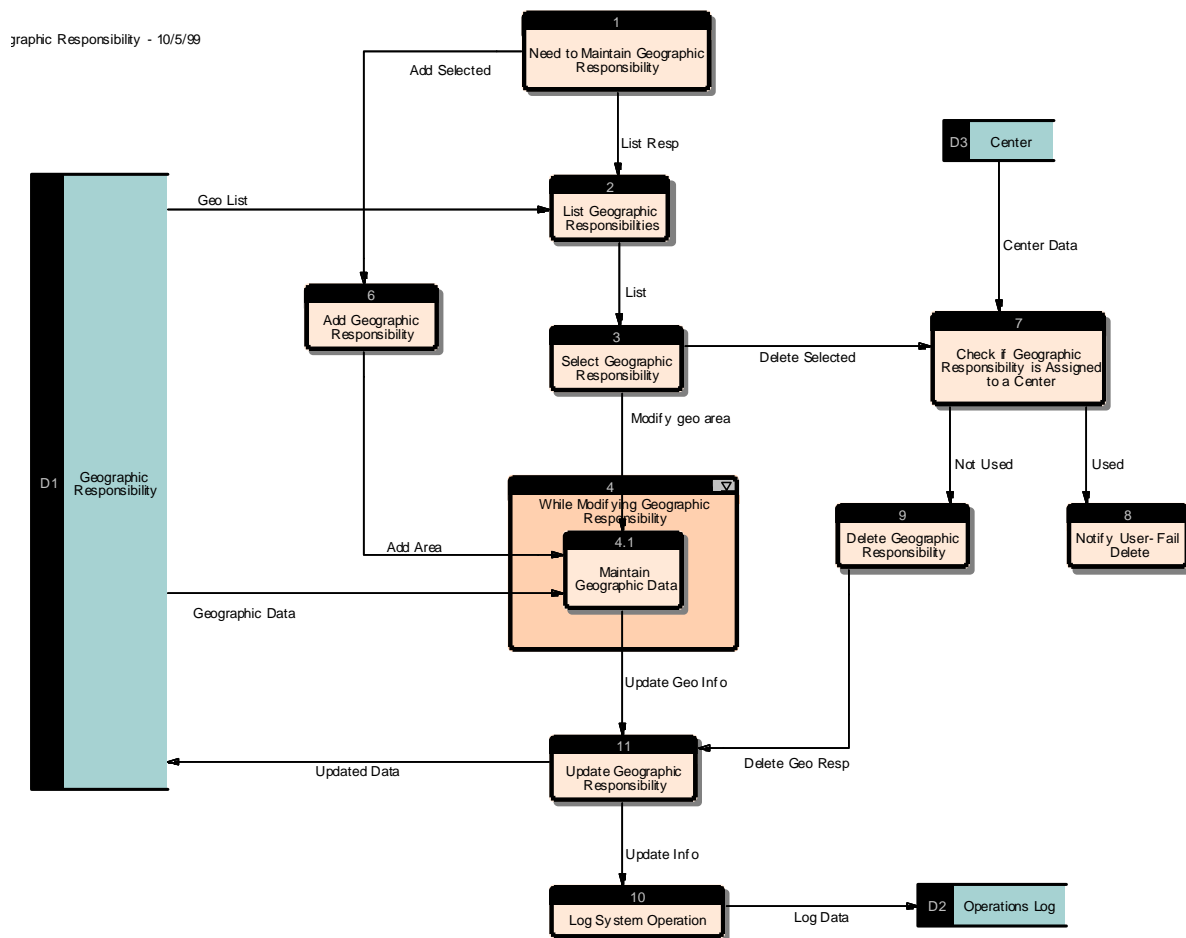
Figure 2-12. Maintain Geographic Responsibility

2.2.4.1.1.6   Maintain Center and AOR

The Maintain Center and AOR process maintains the table of centers defined to the system. Basic center information includes the identity of the center and its hierarchical responsibility relationship to other centers. This process also maintains the relationships to respective Functional Responsibilities and Geographic Area of Responsibility for each center.

The hierarchical responsibility relationship identifies where to forward Alerts that are not deliverable to or responded by the center. Functional Responsibilities identify the system functions the center is permitted to perform and the types of Alerts this center may receive. The Geographic Area of Responsibility identifies the physical area of coverage for the center, further defining those devices and related Alerts that may be sent to the center.

CHART II Business Area Architecture Report   59   August 23, 2000
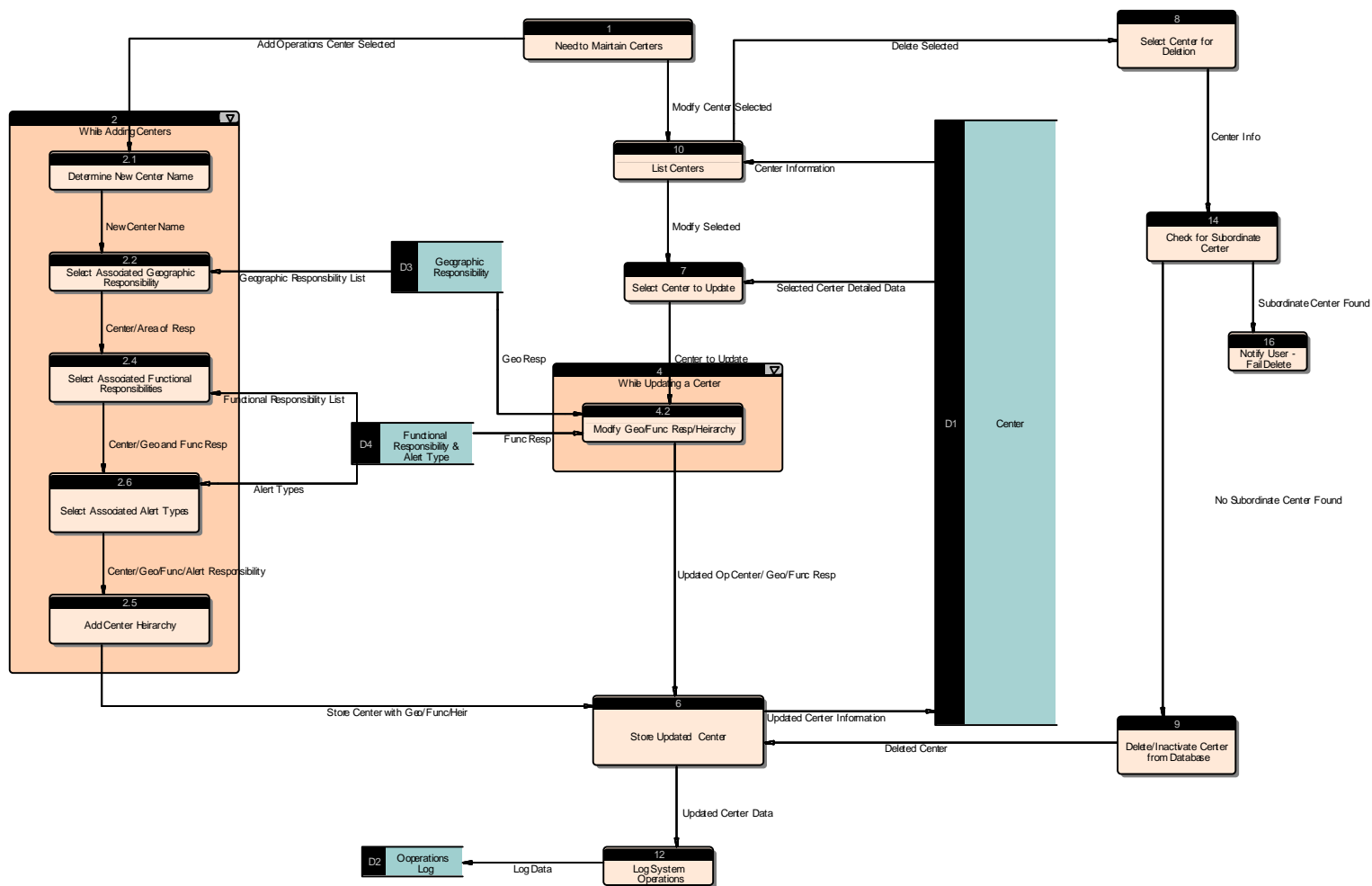
Figure 2-13. Maintain Center and AOR

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2.2.4.1.2   Operational Control

The Operational Control group of processes identifies the required processes to allow users to log onto or out of the system, to pass operations related information between users, and to manage responsibility for ongoing Incidents and use of the system's shared resources between Traffic Operations centers.

2.2.4.1.2.1   Maintain Center Notepad

The Maintain Center Notepad process provides the capability by which shift supervisors may record and inform users at the center of pertinent information. Each center will have a free text notepad maintained by Shift Supervisor(s), where the Shift Supervisor(s) may enter any information to be passed onto users (for the same center) when the users Logon to the system. The View Center Situation Data process displays the contents of the notepad to the user as a step in the Logon process.

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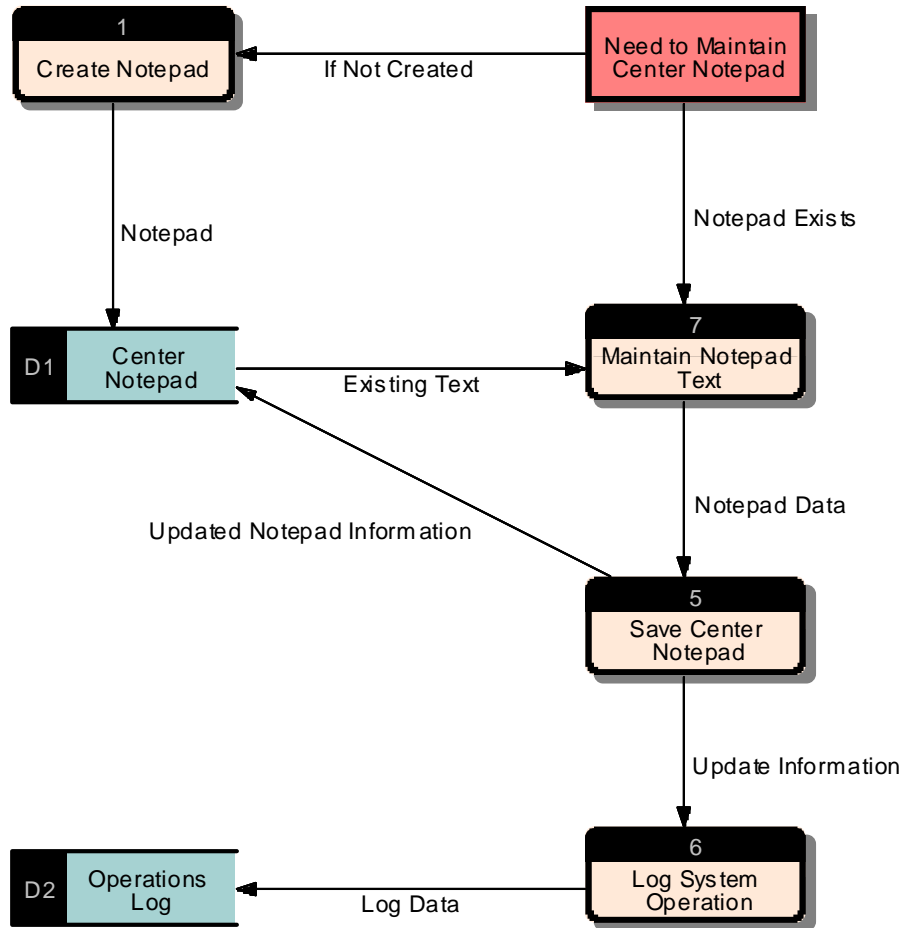
Figure 2-14. Maintain Center Notepad

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2.2.4.1.2.2 User Logon

The User Logon process verifies the user as a CHART II user and initializes the controls for whatever role has been assigned to that user.

In the process design workshops, it was determined that the system steps to completing a User Logon should include the following:

- Machine
- Network
- Database
- Functional Rights
- Area of Responsibility

During logon, the CHART II system first logs into the user's machine and, if necessary, it logs into the network. If there are three unsuccessful attempts to login with an ID, the ID is locked and the information is logged. Once the machine/network logon is successful, the system logs into the database, which allows the retrieval of the user's authorized centers. If the user is authorized Logon to multiple centers, he/she will be requested to identify the center to be related for this session; if only authorized Logon to a single center, the system will relate the user to that center. Upon determination of the center for the session, the system will match users Functional Rights with the center's Functional Responsibilities and determine the user's Functional Rights for this session. The user's GUI Preferences are retrieved and the CHART application is initiated. All steps are logged.

The View Center Situation Data process is performed after the application is initiated.

Functional Rights are indirectly related to the user through the Role(s) assigned to the user. Area of Responsibility is determined based on the center selected for the session and the Geographic Area of Responsibility related to the center at the time of the Logon.

Area of Responsibility refers to the types of alarms a center may receive from the system, as well as the geographical area from which these alarms may be generated.

CHART II Business Area Architecture Report   63   August 23, 2000
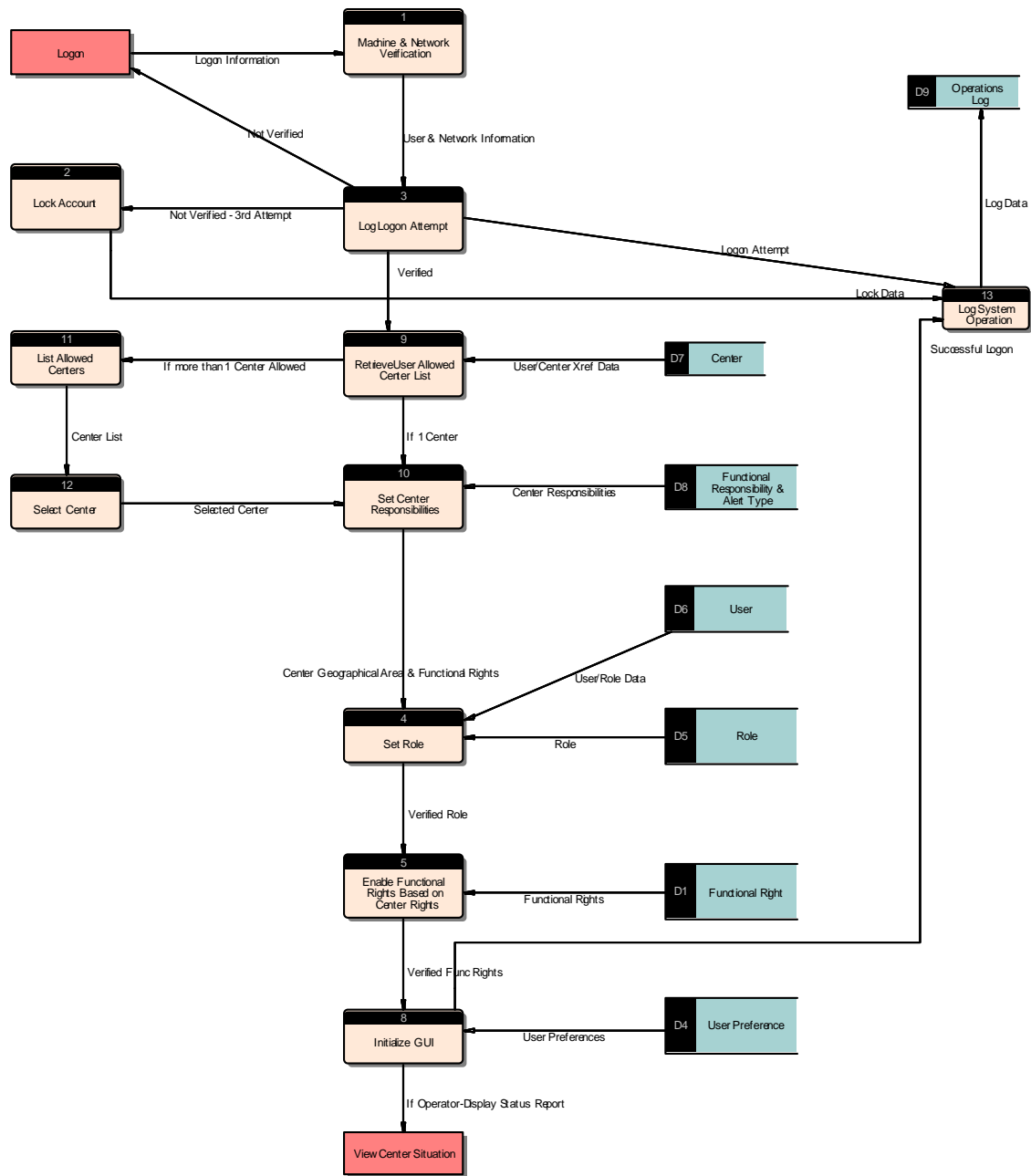
Figure 2-15. User Logon

2.2.4.1.2.3 View Center Situation

The View Center Situation Data process provides CHART users at SHA centers with a view of the recent and current center activities as related to Incident Logs, Action Logs, Device Failures, and Alerts. It is not expected to display this information to non-SHA users, such as the media or those accessing the system only to retrieve Archived data.

The term 'recent' refers to center activities over the last number of hours as specified in the System Parameters. The center notepad is displayed to inform the user of information from the Shift Supervisor.

The View Center Situation Data will be somewhat different for each type of center. For example, the full set of situation data described above is for the SOC and TOCs. A Maintenance Shop would not receive a view of Incident Logs or Action Logs, but would receive a view of Device Failures and Alerts related to that center's area of responsibility.

CHART II Business Area Architecture Report   65   August 23, 2000
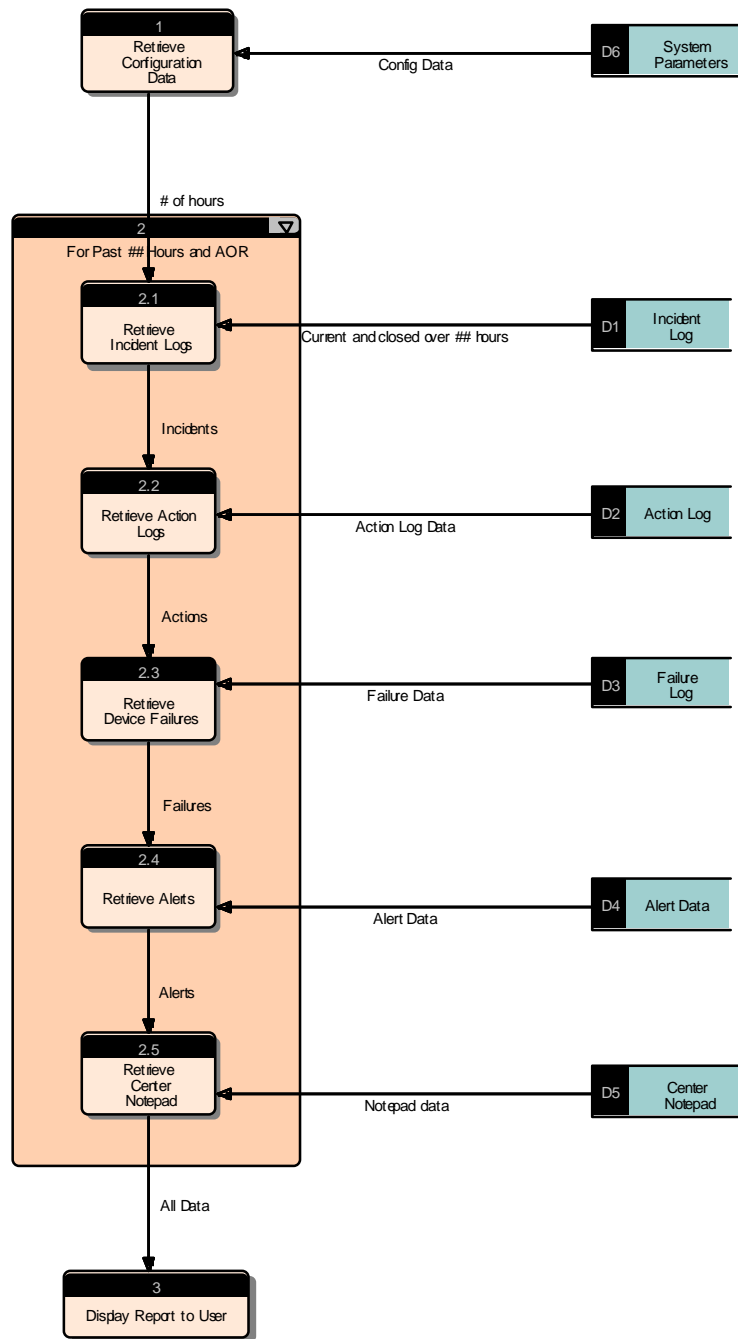
Figure 2-16. View Center Situation

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2.2.4.1.2.4 Maintain User Preferences

The Maintain User Preferences process maintains the data values that control user-selectable GUI and system capabilities so that the User Preferences are initiated each time the user starts the application.

Implementation Consideration: application design will have to address any variances in user preferences affected by a user having multiple authorized centers with different sets of Functional Responsibilities.

Maintain User Preferences - 9/9/99
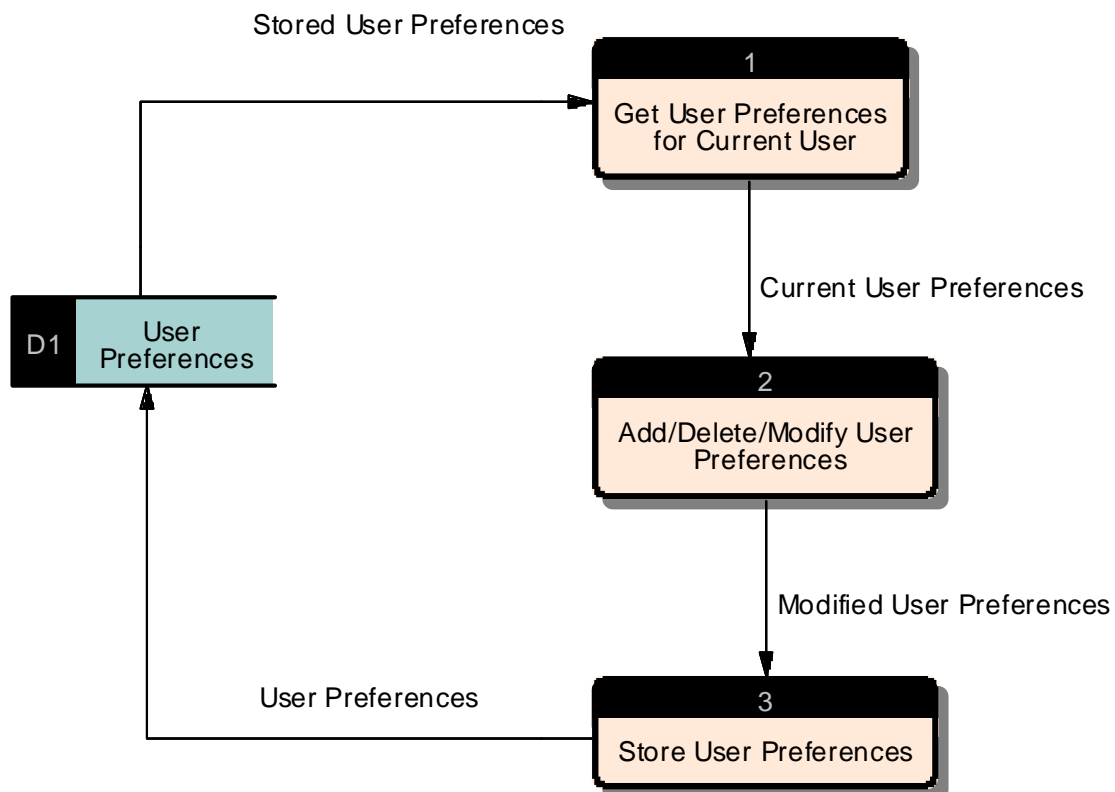
Figure 2-17. Maintain User Preferences

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2.2.4.1.2.5   Maintain Operator's Notepad

The Maintain Operator's Notepad process views and maintains a free text area for each user in which the user may store pertinent/personalized information. Examples of data expected to be stored in this free text area include key phone numbers, operator's procedural notes, etc. All operators are expected to maintain their own notepads with the information they determine to be important.

As operators may be assigned at various centers at various times, the system must ensure that the operator's notepad is available wherever the operator is located across the system.

It is not anticipated that all CHART users will need this capability and Functional Rights need to be granted to users to provide the capability to the user. Only the creating user may have access to his/her notepad.

CHART II Business Area Architecture Report   68   August 23, 2000
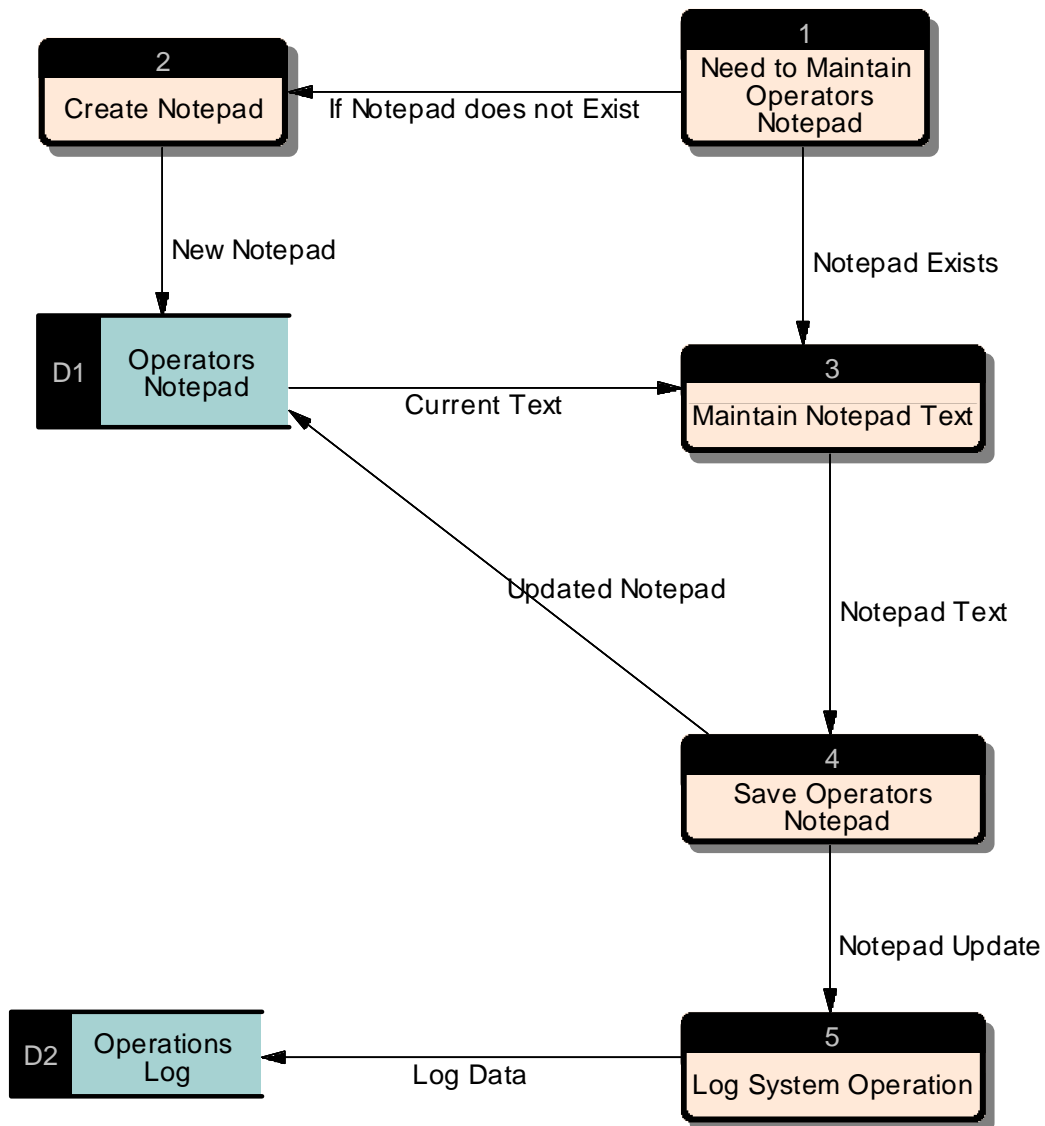
Figure 2-18. Maintain Operator's Notepad

2.2.4.1.2.6 Perform Chart Chat

The Perform CHART Chat process provides CHART operators with the capability to communicate between workstations over the network. The CHART Chat process provides the Chat user with a list of other online users from which the Chat user selects those other online users to which he/she wishes to send a message. The Chat user then enters a free text message that is transmitted to the selected recipients.

The workshop participants determined that there was no need to record/retain information about the use of Chat or of the contents of the messages sent.

Implementation Consideration: a version of CHART Chat was recently completed under the Web development effort. This application is available to CHART II to integrate into the CHART II application.

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```
┌──────────────────────────────┐
│              1               │
├──────────────────────────────┤
│        Retrieve List of      │
│      Online Chart Users      │
└──────────────────────────────┘
```

D1 | User

Users Online

Online User List

```
┌──────────────────────────────┐
│              2               │
├──────────────────────────────┤
│        Select Users for      │
│             Chat             │
└──────────────────────────────┘
```

Selected Recipients

```
┌──────────────────────────────┐
│              3               │
├──────────────────────────────┤
│           Type Text          │
└──────────────────────────────┘
```

Message for Users

```
┌──────────────────────────────┐
│              4               │
├──────────────────────────────┤
│       Send Text to Users     │
└──────────────────────────────┘
```
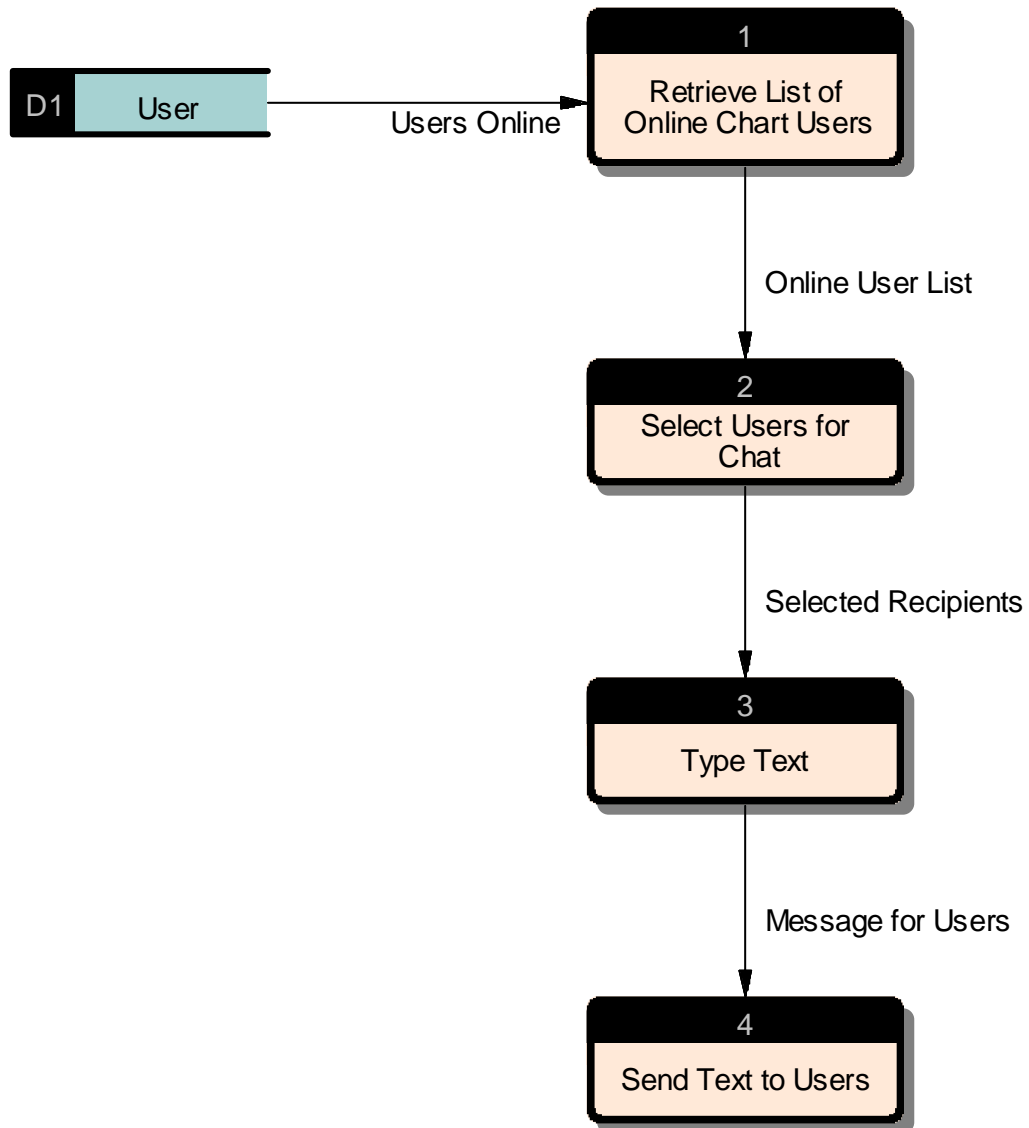
Figure 2-19. Perform Chart Chat

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2.2.4.1.2.7 Logout

The Logout process validates that the last user to request logout at a center has released control or transferred all responsibilities. If not, the logout is failed and the user is put into the Transfer Shared Resources processes to perform the transfer of these resource and responsibilities. A successful Logout will disconnect a user from the application system and the network.
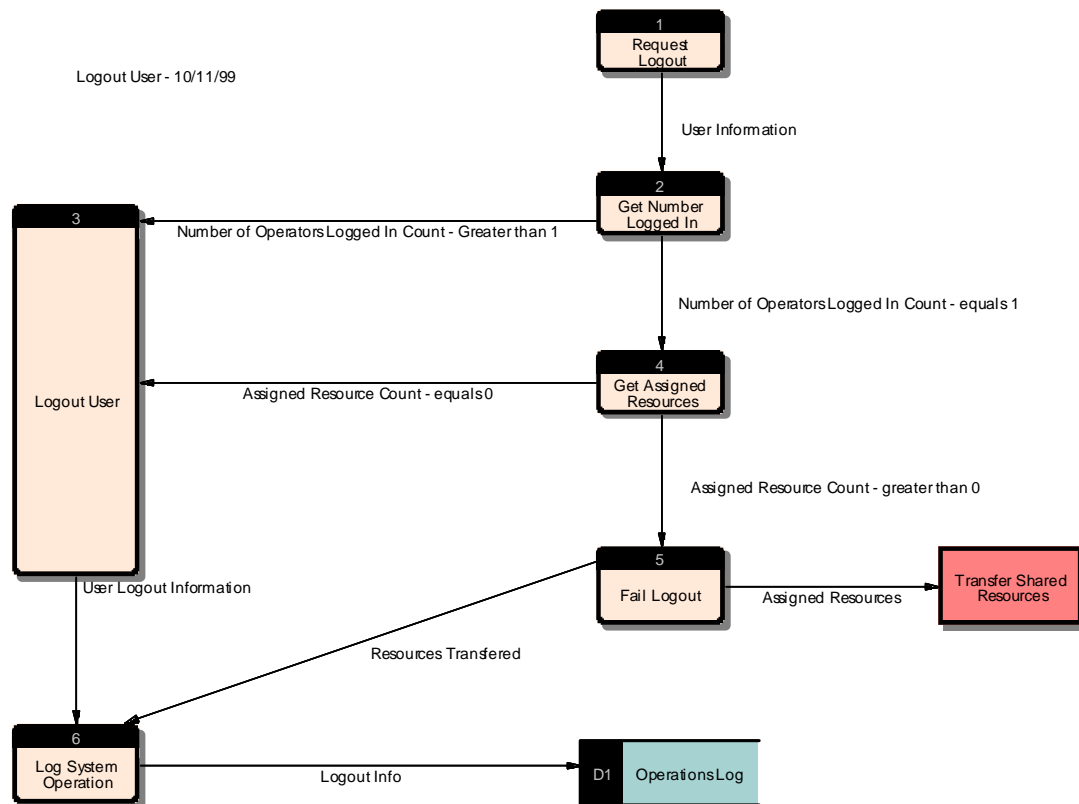
Figure 2-20. Logout

2.2.4.1.2.8 Change User

The Change User process provides the capability for a user to logon to a Workstation to replace the current user. The intent of this feature is for use during a shift change to overcome the check in the Logout process for the last user logging out for a center. The new user logging onto the system must be granted the *same* center access as the current user in order to take over responsibility for the shared resources currently assigned to the center.

Change User - 10/6/99
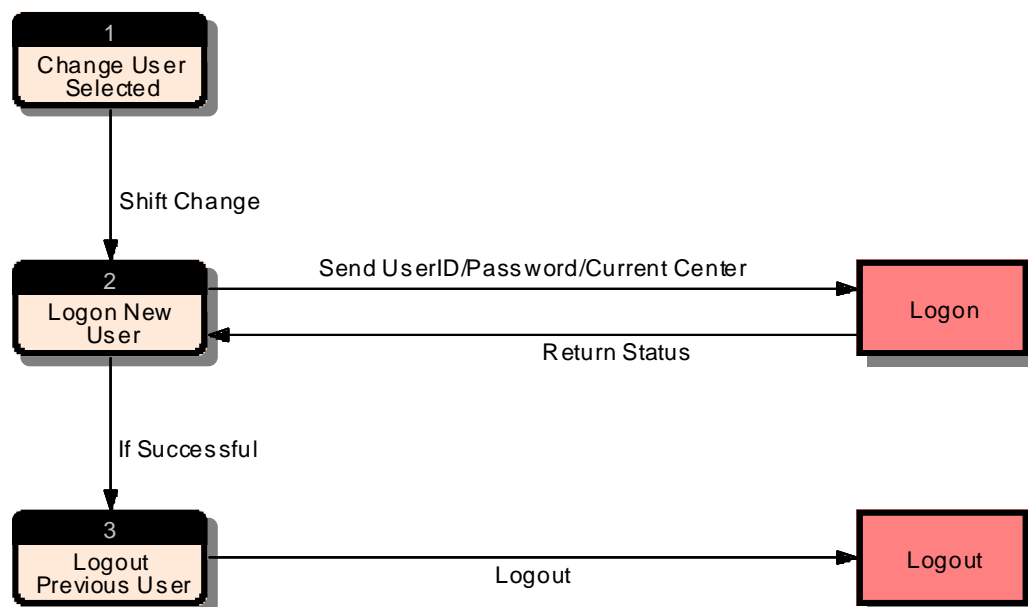
Figure 2-21. Change User

2.2.4.1.2.9 Transfer Resources

The Transfer Resources process allows for a user at a given center to transfer responsibility for ongoing activities and controlled resources to another center.

This process may be used at any time to transfer responsibility between centers, and is to be performed as part of the closing of a center at the end of a workday. The last user at a center will not be permitted to logout of the system until these transfers are performed and the system does not detect any open logs or resources assigned to that center.

When resources are transferred and alert is sent to the receiving center notifying them of the transfer. Acknowledgment is not required for completion of the transfer.

This process applies to the TOCs only.

Notes from the process design workshops included the following:

1. At the end of the day, all devices and open incident logs must be transferred to the SOC before the last operator logs out.

2. The transfer of devices and incident logs will be displayed on the recipients' ticker and an acknowledgment will be recorded when the devices/logs are accepted.

3. The transfer will show up on the ticker of all logged in users at the recipient center.

4. At the end of a shift at the TOC (not the end of the day), the Change User process will be used to avoid having the last user attempt to Logout of the center.
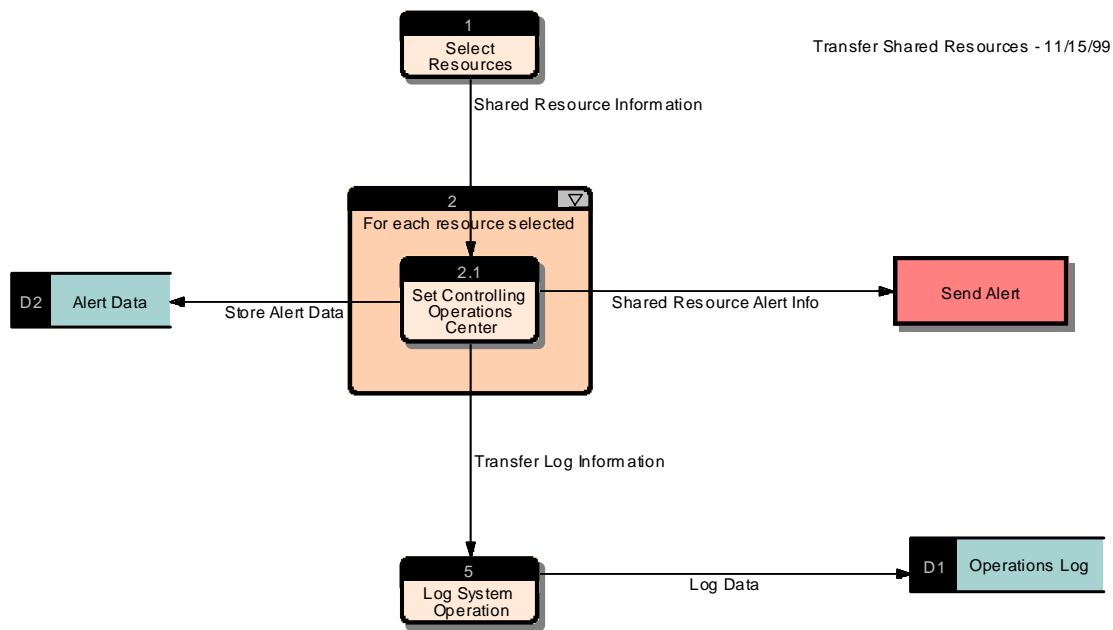
Figure 2-22. Transfer Resources

2.2.4.1.2.10 Respond to Request to Transfer Resources

The Respond to Request to Transfer Resources Alert process is used to allow the individual to receive the alert, capture when the alert was acknowledged, and display the resources that have been transferred.

Respond to Request to Transfer Resources Alert - 11/15/99
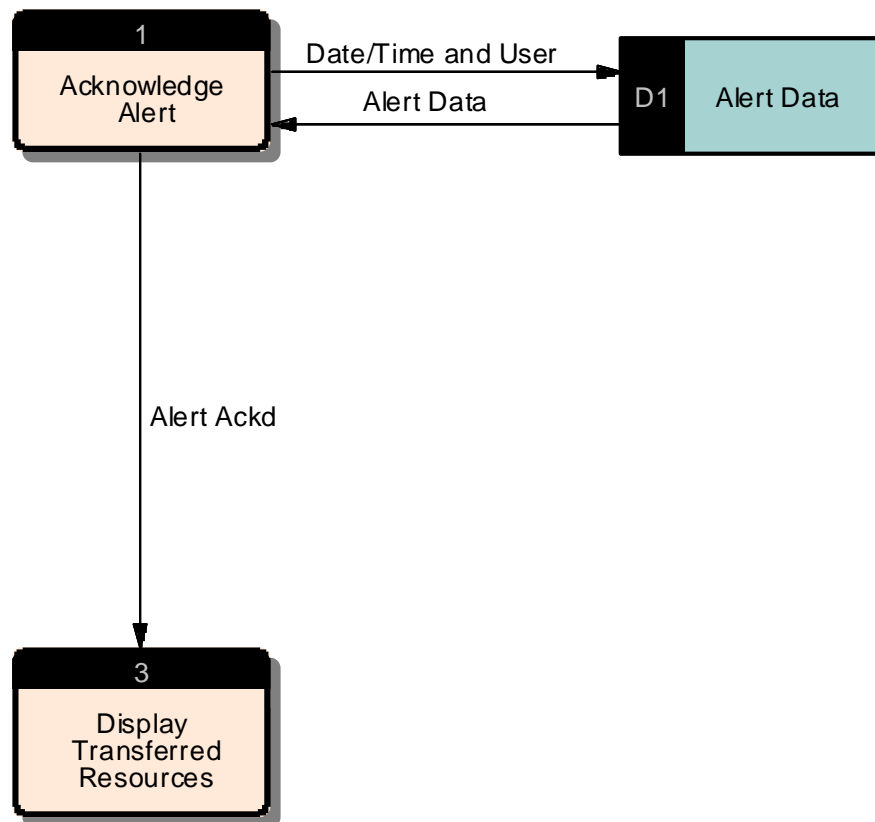
Figure 2-23. Respond to Request to Transfer Resources

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2.2.4.1.3 Configuration Processes

The Configuration Processes group of processes maintains those data items that configure and control the actions of the system processes. These include the System Parameters and Links. System Parameters are those data items that supply control information to the processes.

Links define segments of the highways as units to be measured and monitored for traffic management. These defined segments determine the units of information to be displayed on the visual Map to provide traveler information related to current traffic conditions.

2.2.4.1.3.1 Maintain System Parameters

The Maintain System Parameters process maintains the data values for the System Parameters that control the other processes in the system. The process provides the authorized user with the capabilities to add and modify System Parameters.

The specification of System Parameters and their values must be closely coordinated with the design of the Applications for CHART II. Since these values are "plugged in" to the applications, accuracy in maintaining these parameters is critical to the continued operation of the system.

Examples of System Parameters include:

- Time in advance of EORS Permit start time to activate EORS icon

- Interval to wait to send Alert for Delinquent Equipment Status

- Determining which response plans need to be executed based on which Counties are declaring a snow emergency.

- Frequency, time of day, and permit time range for downloading EORS permit data

- Frequency for checking System Components

- Frequency for checking for National Weather Service weather alert

- Frequency for refreshing default AVCM Presets

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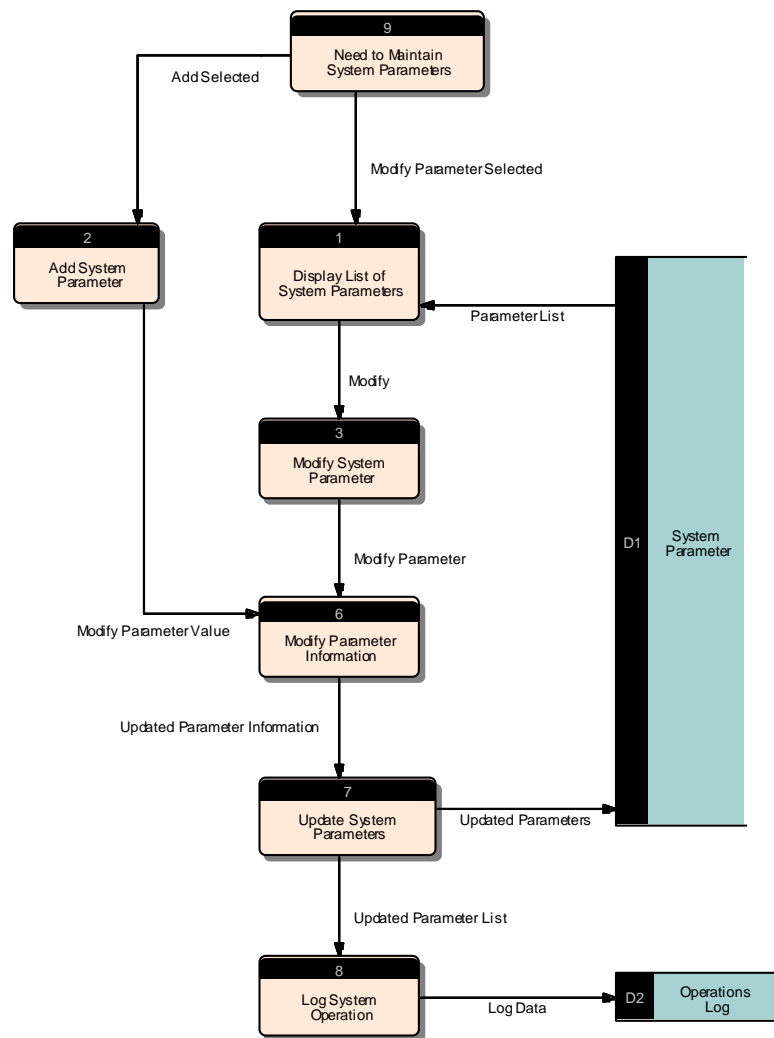
Figure 2-24. Maintain System Parameters

2.2.4.1.3.2 Maintain Links

The Maintain Links process provides the capabilities to maintain the data values that define Links to the system, and therefore configure and control the units of traffic information maintained and monitored in the system. Maintenance of Link data includes relating Links to specific Detectors and to the CHART map data. The relation to specific Detectors is necessary to relate gathered volume, occupancy, and speed data to specific Links. The relation to CHART map data is necessary to specify where each Link is to be displayed on the map.

Conceptually, Links may be defined as detector-to-detector segments, exit-to-exit segments, fixed length segments of a highway, or any other unit deemed appropriate. Links for CHART II have not been specifically defined as of the writing of this report, and may not be defined until XAD.

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Maintain Links -9/17/99
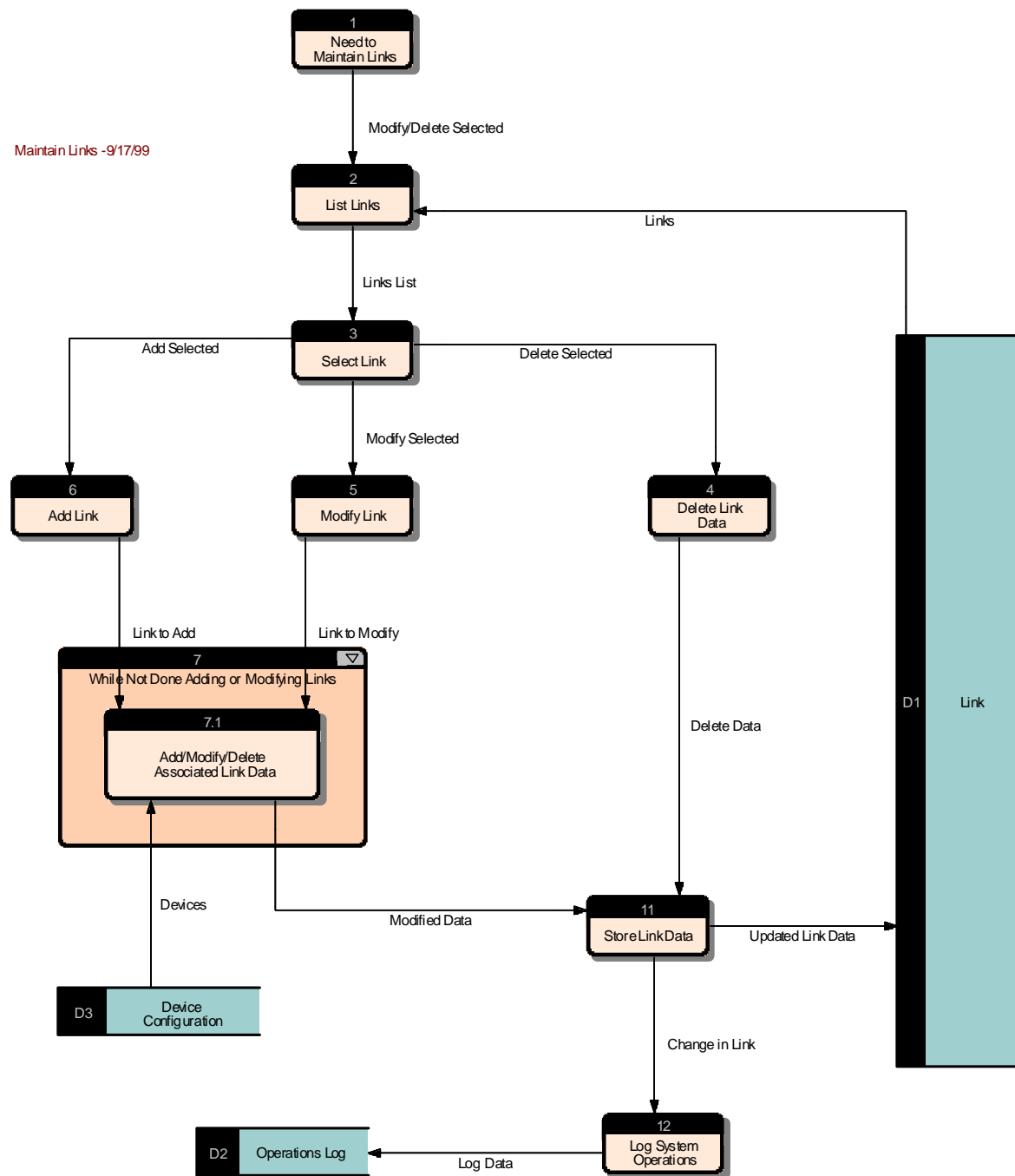
Figure 2-25. Maintain Links

2.2.4.1.4 Maintain FITM Plans

The Maintain FITM Plans process provides the capabilities to maintain electronic versions of the FITM currently maintained in paper format. FITM plans consist of diagrams of detour routes, text descriptions of the detour routes, and text lists of required equipment and actions to be taken to implement the plan. A FITM plan covers a highway between two exits, and includes information for establishing detours in either direction of travel on the highway.

The Maintain FITM Plans process defines a plan by the exits covered and the travel direction, implying that today's paper plans may result in two or more electronic plans. The process provides for the creation, modification and deletion of plans. Each plan is composed of a graphics part, textual description, and textual directions. The graphics part of a plan may be scans of annotated maps, may be electronic maps, or may be layers on the GUI display map (this is to be determined at XAD). The textual description *part* is joined with the graphic *part.* This is used to form a transmission to the public about the detour when it is implemented. The textual directions are instructions to CHART and other agencies staff managing the incident, identifying the need and placement of traffic control devices (arrow boards, cones, etc.) and the location and messages to be displayed on DMS or HAR devices.

This maintenance of FITM plans in electronic format is expected to be useful in maintaining hard copies of FITM plans carried in the CHART vehicles and FITM trailers. A manual process will need to be established to print and distribute change pages to hard copy folders, and have the folders updated by page replacements.

Operators have two alternative methods for initiating a FITM plan. The first method is to follow the FITM plan documentation and perform the actions described in the documentation. The second method is to setup Plans using the Maintain Plans process, and then allowing the implementation of a FITM plan using the Activate Plan process. It is not expected at this time that the system will automatically activate a designated Plan when an Incident Log is identified as a FITM condition, as it will take a significant amount of time to develop Plans for all of the FITM plans. At such time as all the Plans have been developed, the activation of a FITM related Plan could be implemented based on the location and direction of an Incident.

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FITM Plan Data may consist these types of data:
1. Scanned FITM Plan Image for each direction including:
   Detour Text
   Image
   Equipment Deployment Instructions
2. Vector Detour Data
3. Text

1
Need to Maintain FITM Plans

Modify/Delete FITM Plan

2
List FITM Plans

Plan List

FITM Plan List

4
Add FITM Plan

Add New FITM Plan

3
Select FITM Plan

Delete Selected Plan

7
Delete FITM Plan

Delete FITM Plan

Modify Selected Plan

Add FITM Plan Data

6
Modify FITM Plan

Modify FITM Plan Data

D1 FITM Plan

8
While Not Done Adding or Modifying FITM Plans

8.1
Add/Modify/Delete Associated FITM Data

Updated Data

5
Store FITM Data

Updated FITM Plan Data

Log FITM Plan Update

D2 Operations Log

Log Data

9
Log System Operation

Figure 2-26. Maintain FITM Plans

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2.2.4.1.5 Map Configuration

The Map Configuration process group contains a single process to maintain Map Data for the CHART II system.

2.2.4.1.5.1 Update MDOT GIS Map Data

The Update MDOT GIS Map Data process provides the capabilities to download map data from the MDOT GIS system. This process allows the CHART II Map information to be periodically synchronized with the MDOT map information and eliminates the need for frequent CHART II system maintenance to maintain the Map information. This process retrieves new data from the MDOT system on an as-required basis, performs any necessary data conversion, and stores the converted data in CHART II. Details of this process will be determined at detail design.

Update MDot GIS Map Data - 8/23/99
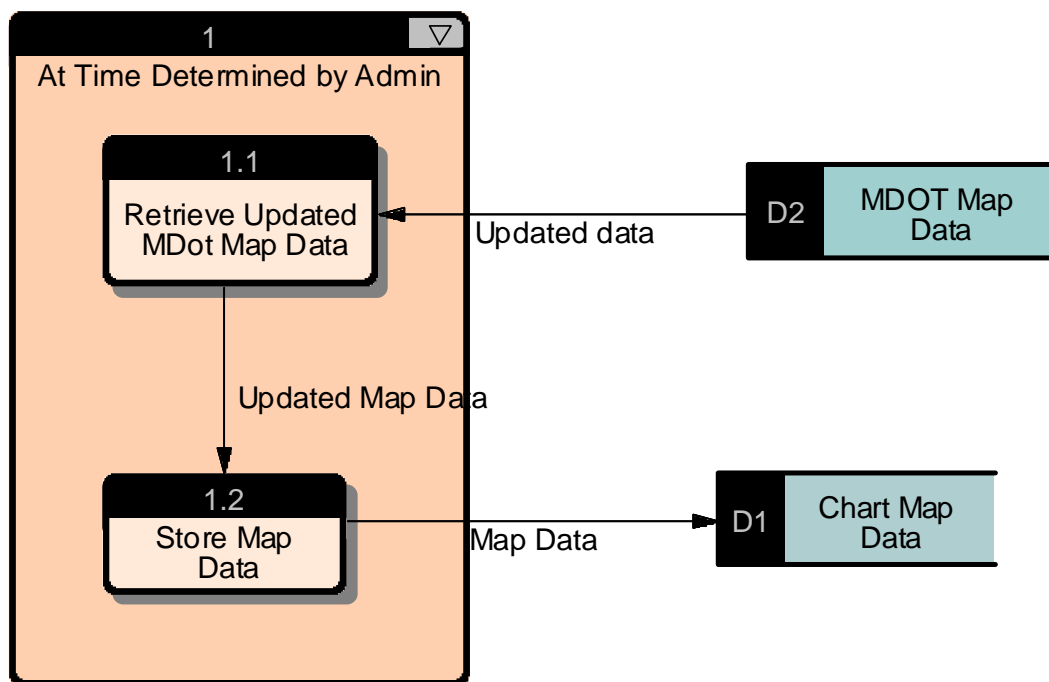
Figure 2-27. Update MDOT GIS Map Data

2.2.4.2 System Configuration and Status

The System Configuration and Status processes include processes necessary to define, setup, and monitor the hardware, software, and devices of the CHART II system. These processes are divided into groups related to components and devices. The following figure identifies the individual processes within each group
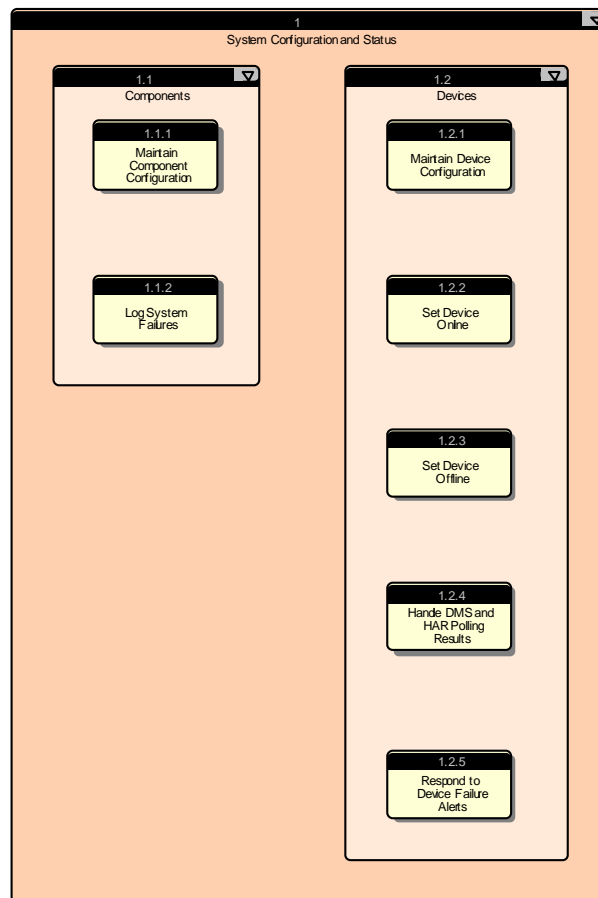
Figure 2-28. System Configuration and Status

2.2.4.2.1 Components

The Components group allows for the System Administrator to maintain the overall configuration of the CHART II system and for the Operators to monitor the health of each of the components.

2.2.4.2.1.1 Maintain Component Configuration

The Maintain Component Configuration process maintains tables of data to identify computer system components (*i.e.,* servers, clients, software, communications, legacy systems). Component configuration data will include data to control the frequency and type of status checks to be performed on the components.
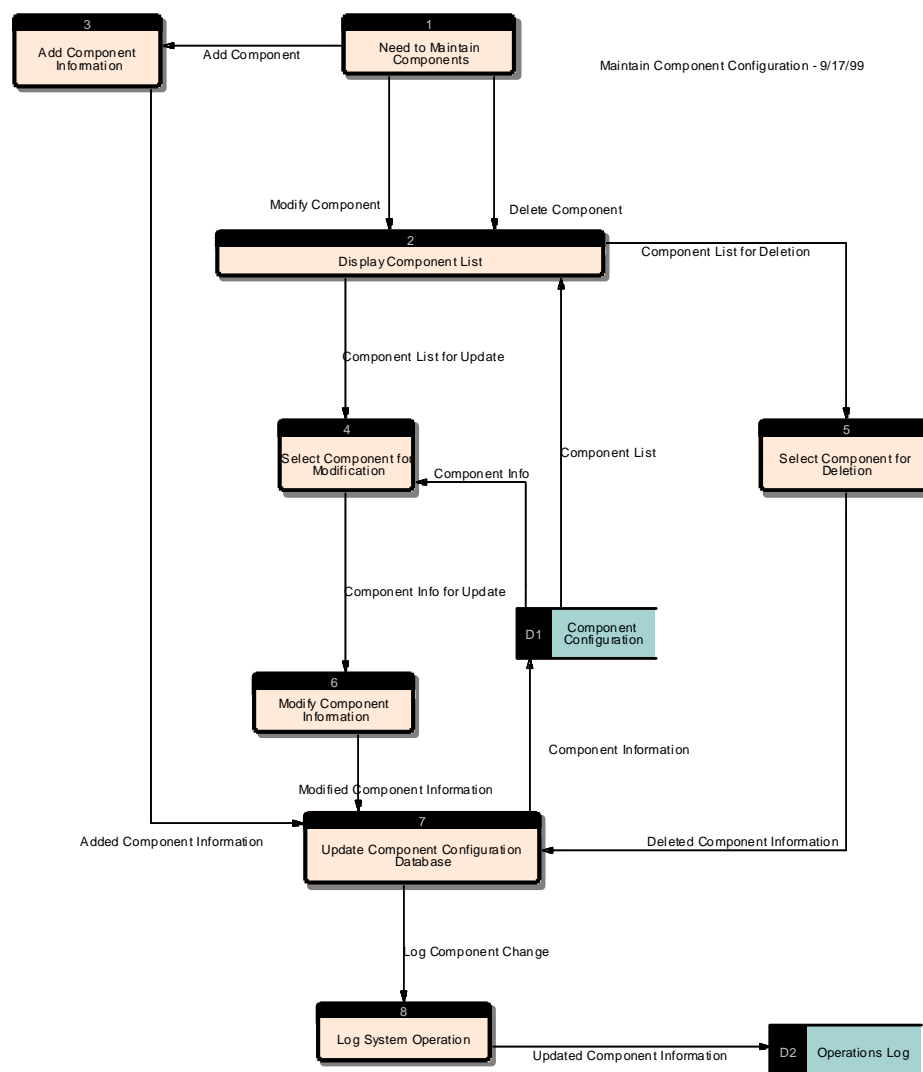
Figure 2-29. Maintain Component Configuration

2.2.4.2.1.2 Log System Failures

The Log System Failures process performs the writing to a database table of system failures when the status of a system component changes to an unhealthy state.

As part of the reliability of the new system, it is expected to poll each system component at a component-specific frequency and identify any failure. Each detected failures is logged and the date/time stamp of the last poll and the status is maintained for each component. Specific system action is taken for certain components to attempt correction of the failed component. Specific components mentioned in the workshop were:

- Servers
- Clients
- Software
- Communications
- Legacy Systems

Representative data to be logged for system failures includes:

- Device identifier
- Last Polled Date/Time Stamp
- Failure type
- Location / variable

From information reported and retained, the system administrators will be able to identify the frequency of failures of specific components, as well as to initiate corrective actions at the time of failure.

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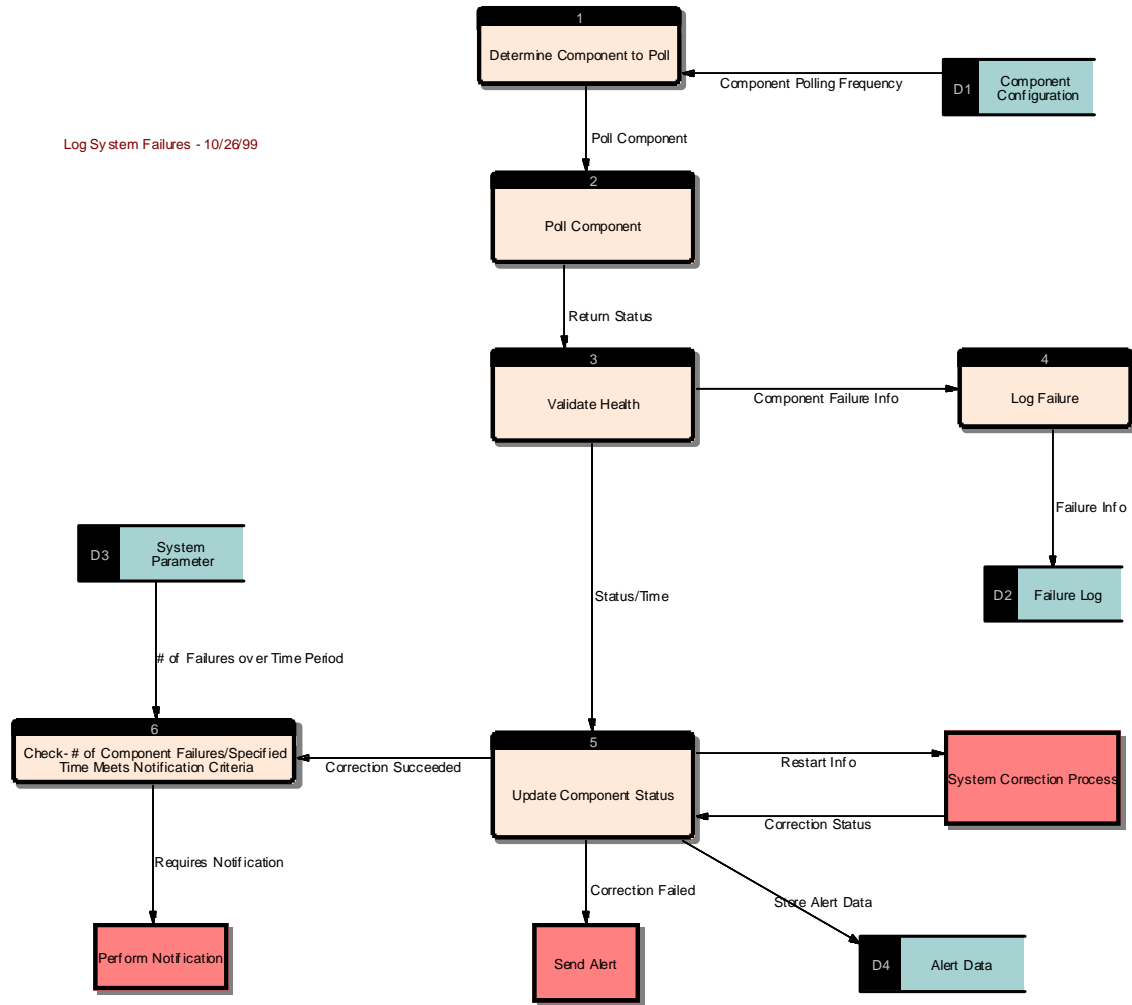
Figure 2-30. Log System Failures

2.2.4.2.2 Devices

The Devices group allows for the Operators to maintain the overall configuration of the CHART II devices and monitor the health of each of the devices.

2.2.4.2.2.1 Maintain Device Configuration

The Maintain Device Configuration process maintains tables of data to identify and control CHART devices such as DMS, HAR, detectors, sensors, cameras, etc.

HAR devices may have related SHAZAM devices and/or DMS devices (with assigned message) that can be activated when a HAR message is broadcast.

Devices include location information so the device may be dynamically assigned to a center based on the current Area of Responsibility for a given center.

Maintain Device Configuration - 10/5/99
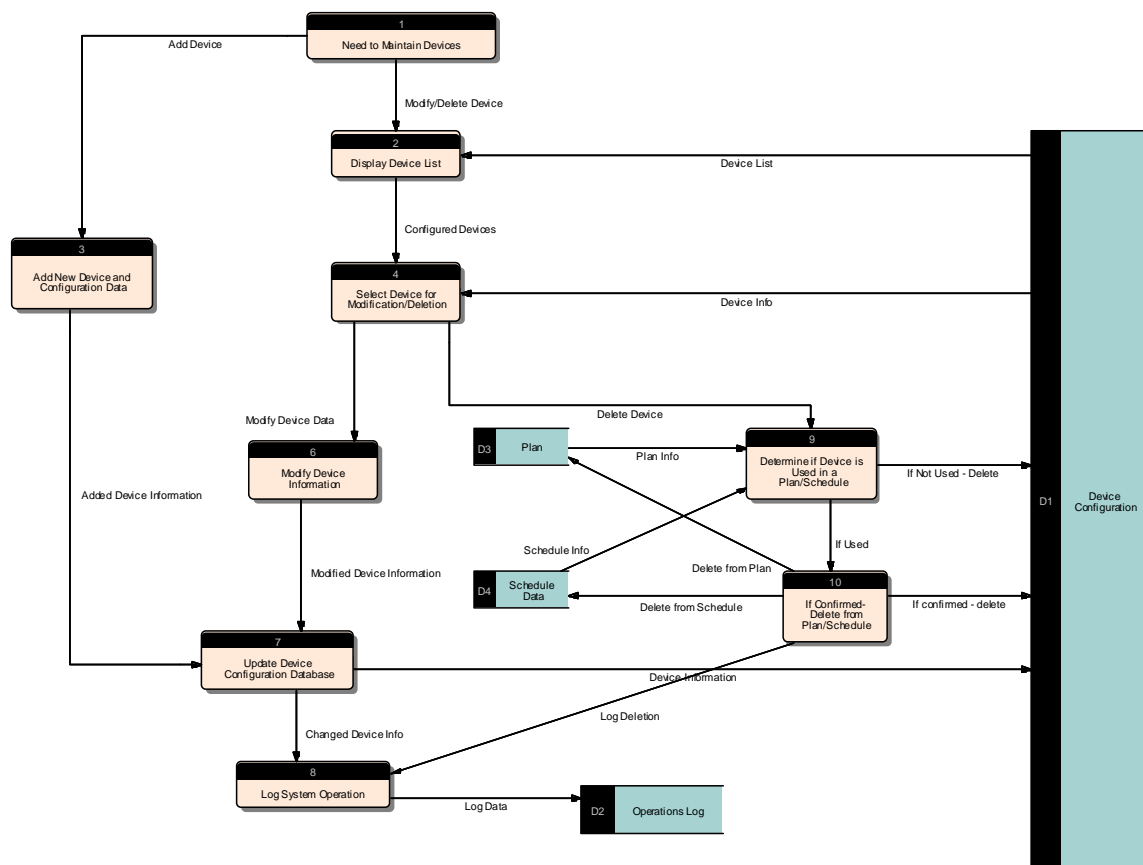
Figure 2-31. Maintain Device Configuration

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2.2.4.2.2.2   Set Device On-Line

The Set Device On-Line process allows an operator to change one or more devices currently off-line (out of service) to an on-line (in service) state and display revised statuses for the selected devices. Setting a device on-line is a *logical* status change in that other system processes will begin to interact with the device. This process assumes the FMS or AVCM application needs to be notified of the status change. Device status information is displayed at the next polling cycle.
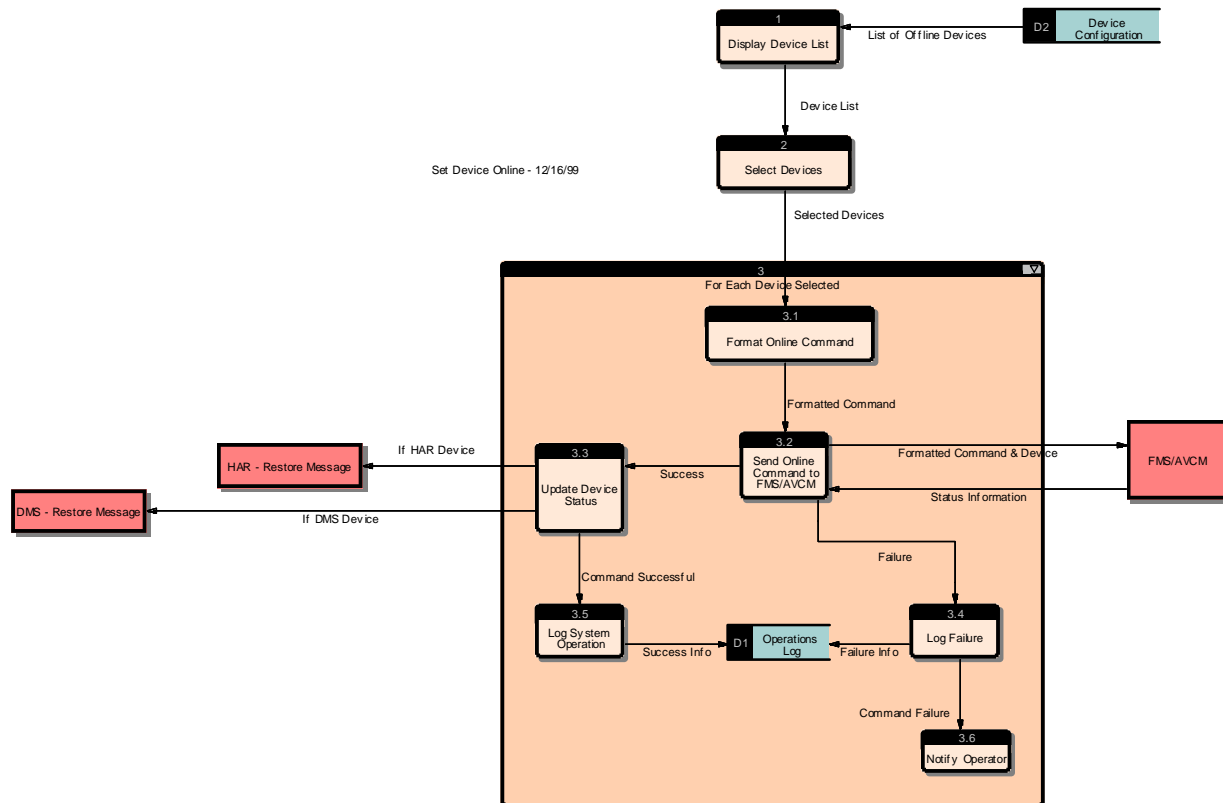
Figure 2-32. Set Device Online

2.2.4.2.2.3 Set Device Off-Line

The Set Device Off-Line process allows an operator to change one or more devices currently on-line (in service) to an off-line (out of service) state and display revised statuses for the selected devices. Setting a device off-line is a *logical* status change in that other system processes will no longer interact with the device. This process assumes the FMS or AVCM application needs to be notified of the status change.
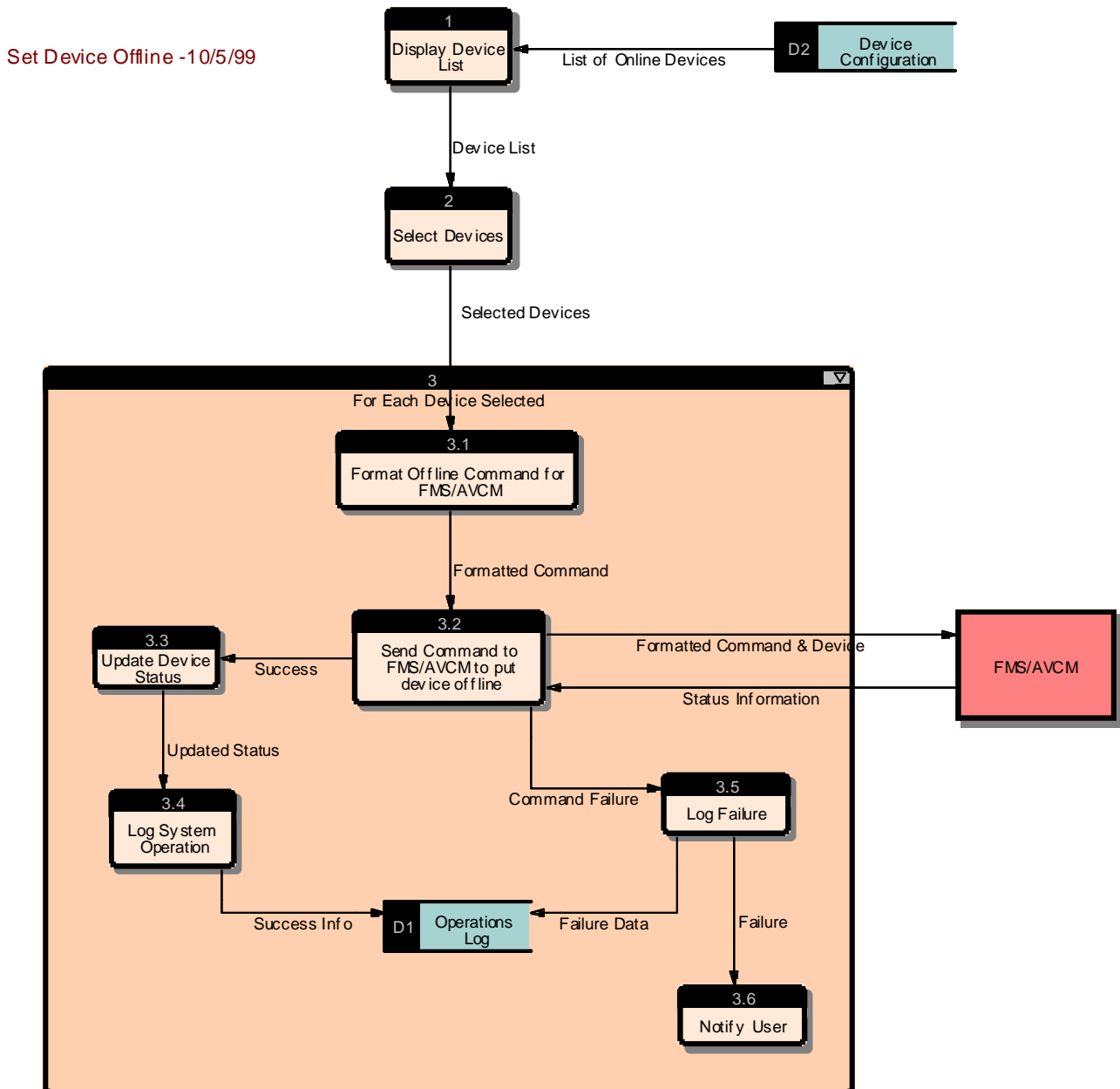
Figure 2-33. Set Device Offline

2.2.4.2.2.4 Set Device to Maintenance Mode

The Set Device to Maintenance Mode process is used to take one or more devices out of the on-line mode, but still have communications with FMS/AVCM to continue in order to send commands. The polling of the device(s) will not, however, be active until the device is returned to an on-line state. This mode will be limited for usage by the maintenance organizations (*i.e.,* signal shop, DMS shop) in order to test devices.
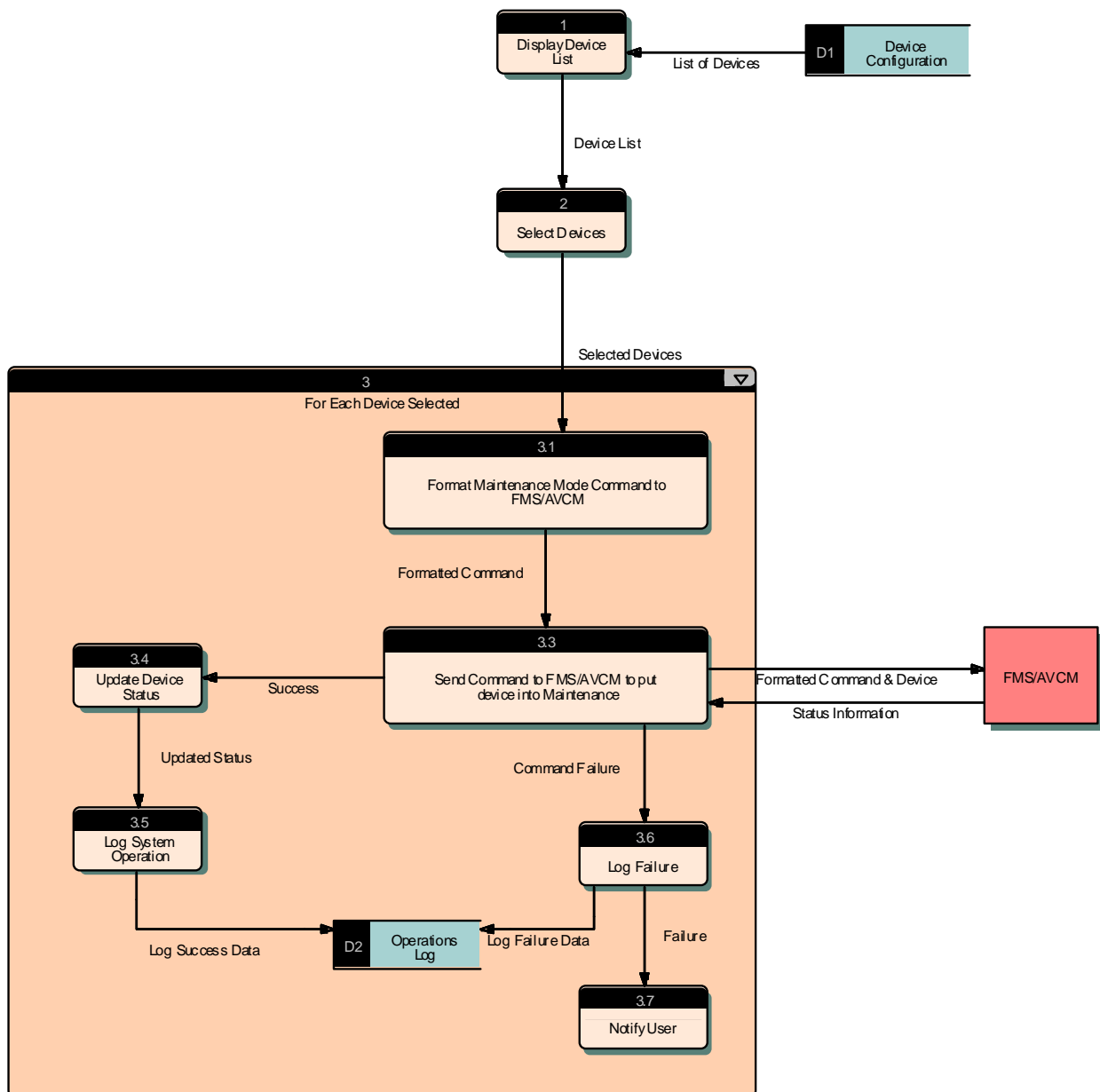
Figure 2-34. Set Device to Maintenance Mode

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2.2.4.2.2.5   Handle DMS and HAR Polling Results

The Handle DMS and HAR Polling Results process updates the result of periodic health checks of HAR and DMS devices. The frequency of polling these devices is controlled by configuration data for the individual devices. FMS will perform the communication with the devices at the specified polling frequency and pass the resulting health check information to CHART II. If the device is within acceptable diagnostic parameters, the status of the device is updated to indicate a healthy status and the date/time stamp of that status. If the device is outside acceptable diagnostic parameters, the failure information is written to the Failure Log. Each device may be configured so that a certain number of failures must be received before an alert is sent. Once the minimum number of failures is reached, an alert is sent to the responsible center, and the status of the device is updated to reflect a failure status and the date/time stamp of the failure.

Implementation consideration: DMS and HAR failures may be indicated as a result of a system component failure. To ensure that the proper maintenance response is initiated, the system must be able to determine the difference between component and device failures and report them accordingly. In other words, the inability to communicate with a DMS may be due to a device failure, a communication failure, or even an FMS failure. CHART II needs to be able to tell the difference and log the proper type of failure so that the appropriate maintenance shop or contractor can be dispatched to make a repair. The system also needs to be able to control the frequency of logging failures for devices already in a failure status, or devices that have failed several times in a short period of time.

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Handle DMS and HAR Polling Results - 12/1/99
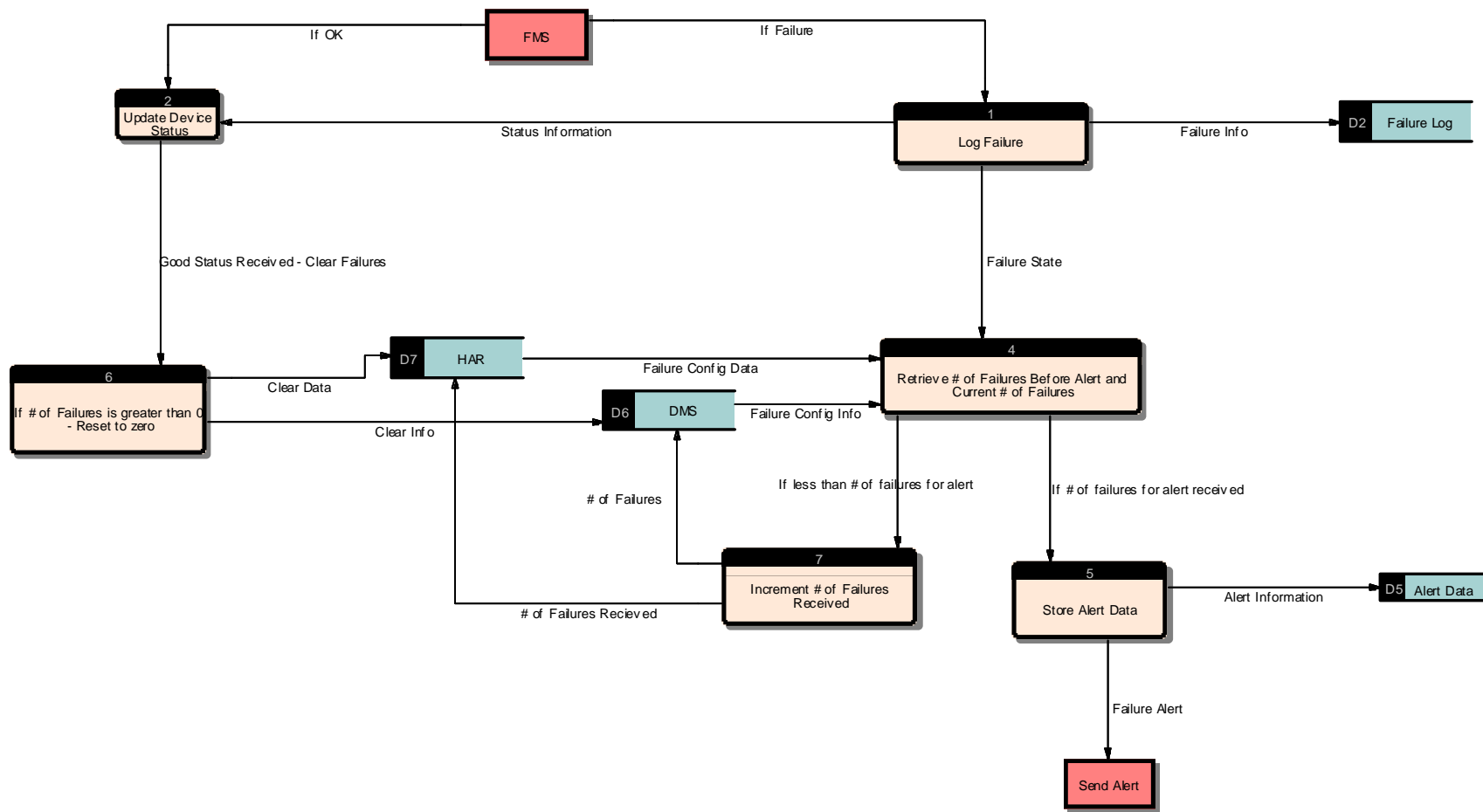
Figure 2-35. Handle DMS and HAR Polling Results

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2.2.4.2.2.6 Respond to Device Failure Alerts

The Respond to Device Failure Alert process allows personnel to acknowledge receipt of a device failure alert for the following devices:

- DMS

- HAR

- Signals

- AVL

Once the alert is acknowledged, any information related to the failure will be input into the associated log.
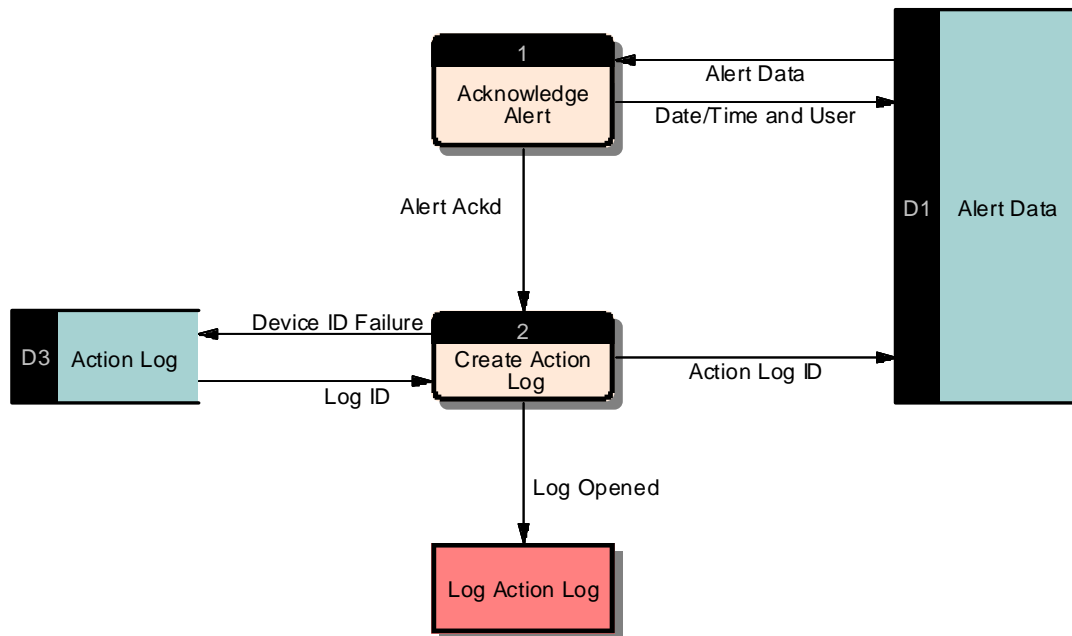
Figure 2-36. Respond to Device Failure Alerts

2.2.4.3 Incident/Event Management

The Incident/Event Management processes provide the capabilities to identify each operational incident or event to be managed by the operations staff, to record various types of operational actions taken, and to monitor results of actions taken to complete the handling of the incident or event. Basically, each operational event is identified as one of several log types with a unique identifier. All actions taken and the status of the incident or event are initiated and tracked from within the log. This log approach allows each unique incident or event to be managed from a single controlling source, allows all data related to a single incident or event to be captured as a single entity, and provides a structured source of information for reviewing actions and calculating performance measurements.

Events are recorded on various Log screens related to the type of event being handled. The intent is to have the Communications Log screen displayed most of the time, as this is the most frequently used log type. By selecting a different type of log, the screen will change to display the format of the selected log type. Date/Time stamps are to be populated at the time the log screen is saved – *not* when the screen is opened as the screen may sit idle for long periods of time.

Comments noted from the process design workshops relative to all the log types are as follows:

1. The Date/Time Stamp associated with each text field on the logs is automatically placed there when the text field is typed in.

2. Checking a check box (*i.e.,* In Service or Out of Service) will automatically place a date/time stamp and text in the text field. The operator may then add specifics, such as which unit or shop is in service.

3. The User ID of the operator and area of responsibility will be captured in the background for all actions.

4. The system will use the location of the logon to determine the center and area of responsibility.

5. The system will have the ability to filter logs based on center, date/time range, and type.

6. Logs will be maintained active within the CHART II system for 2 weeks, as long as the logs are displayed within several seconds of the request. If performance slips, the amount of time a log remains active will be reduced.

7. The automatic log list will include all logs created during the previous 12 hours. If a longer period is needed, the search function is used.

8. The search function must use type (*i.e.,* incident, construction, etc.) as a search criterion.

9. There is a need for a way to trace an incident/disabled log to the original communications log.

10. Save will save *and* close the window.

11. Some fields must be required fields. These are to be determined at a later date.

12. Whenever *On Scene* or *Dispatched* are checked, that is assumed to mean a unit belonging to the agency filling out the log.

CHART II Business Area Architecture Report 95 August 23, 2000
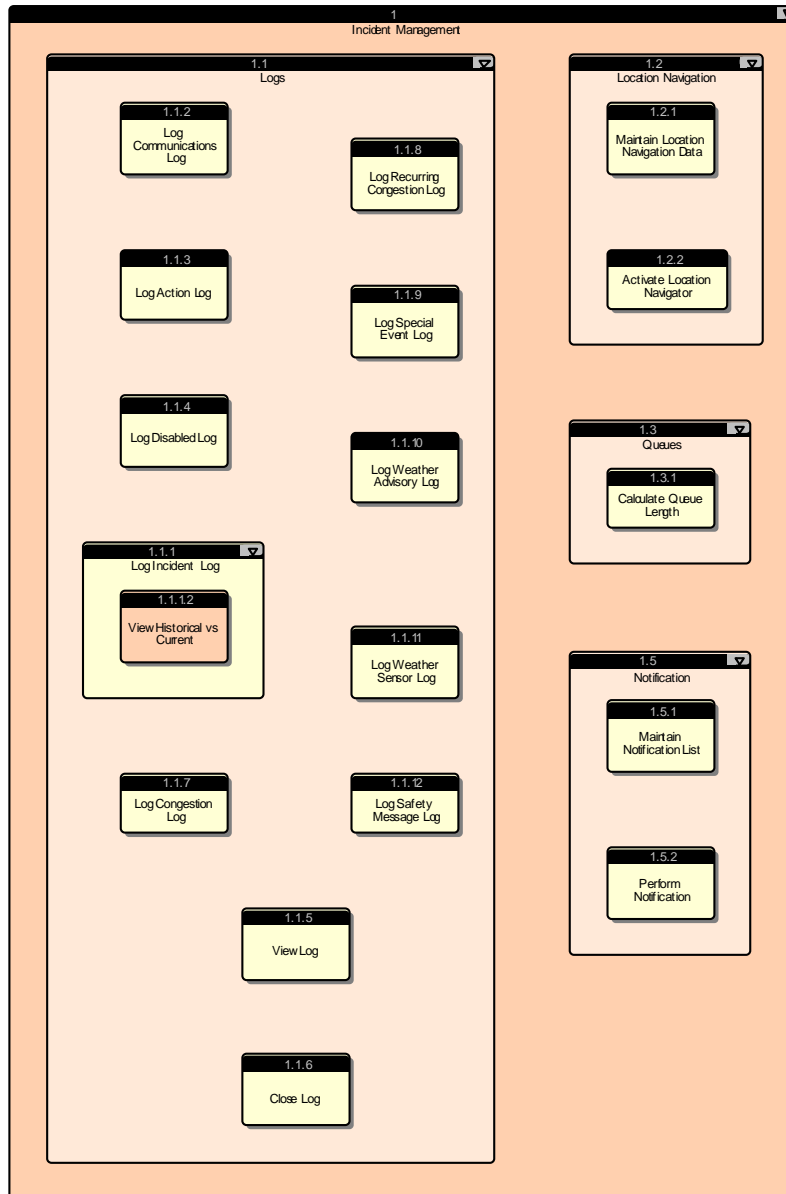
Figure 2-37. Incident Management

2.2.4.3.1 Logs

The Logs process group provides capabilities for operators to record and share information about communications, disabled vehicles, required actions, congestion, and incidents. Logs may be system or operator initiated.

2.2.4.3.1.1 Log Communications Log

The Communications Log process provides the user with the capability to record appropriate information about communications received, but not necessarily requiring any follow up action. From the communications log, the log type can be changed to any other log type.

CHART II Business Area Architecture Report   97   August 23, 2000
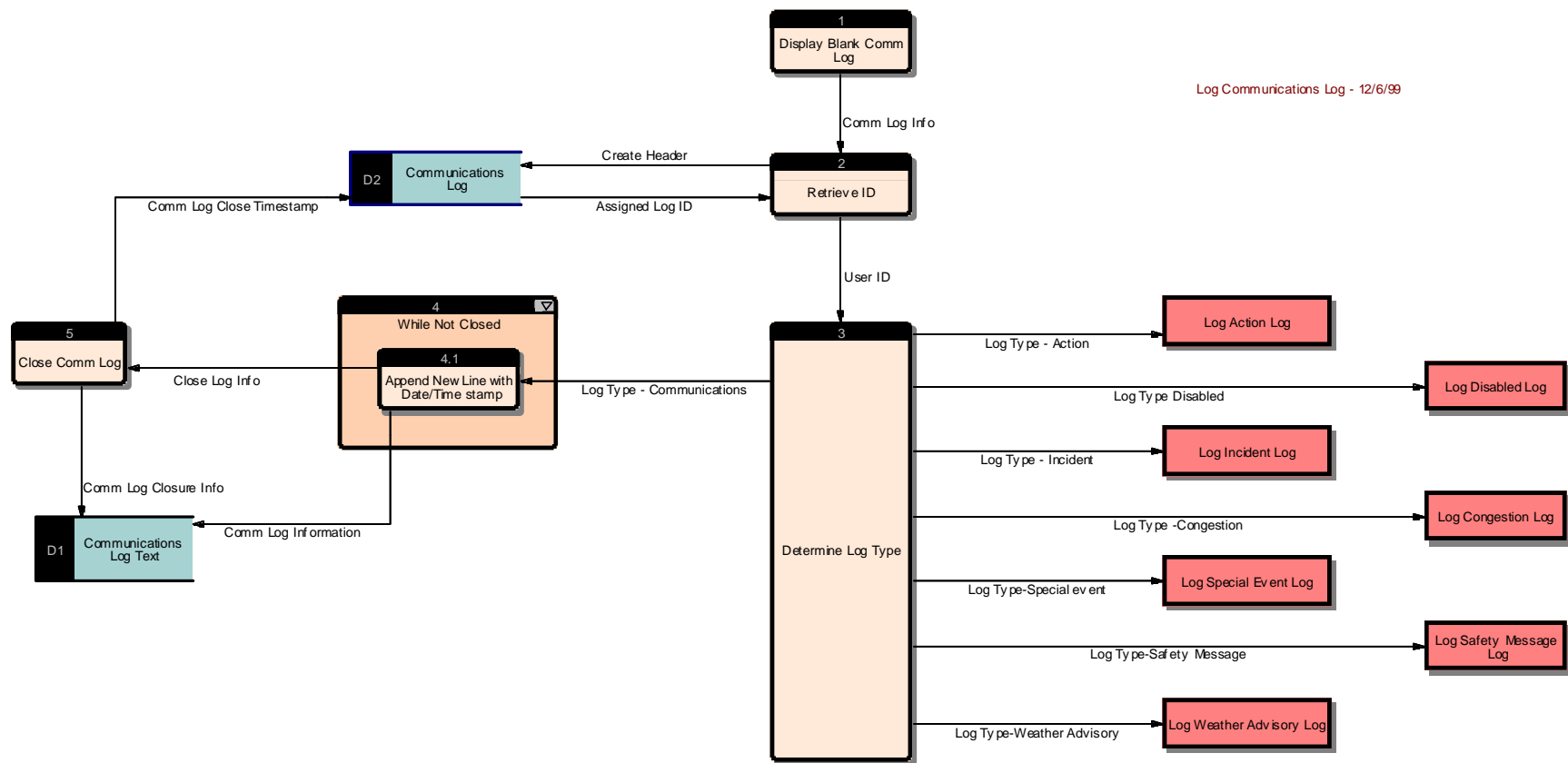
Figure 2-38. Communications Log

A prototype Communications Log screen as discussed in the workshops is illustrated in Figure 2-39. The operator Communications Log is used for each communication between the operator and those outside the center. Simplifying this log will allow the operator to enter the information directly into the system, rather than writing it on paper first. Suggestions were made for simplifying the information including check boxes for the most common communication (*i.e.,* 10-7, 10-8, 10-46, 10-50). It was suggested that a fold/unfold feature would allow the comm log to expand to an incident report. Discussion included the ability to search the comm log database based on a keyword, and the ability to display only the comm logs associated with the operator's area of responsibility. Although 10-codes are used in everyday activities at the SOC/TOCs, it was decided not to use them in the system in order to make the screens more user friendly to other agencies utilizing the system.

Figure 2-39. Prototype Communications Log Screen

2.2.4.3.1.2 Log Action Log

The Log Action Log process allows the user with the correct functional rights to record appropriate information about device failures and non-blockage events (signals, debris, utility, signs, etc.). The operator can notify the responsible shop/agency of a failure by sending a manual alert or transferring responsibility of the open log. Others can also be notified of the failure through e-mail, fax, or page. This process may be system or operator initiated.
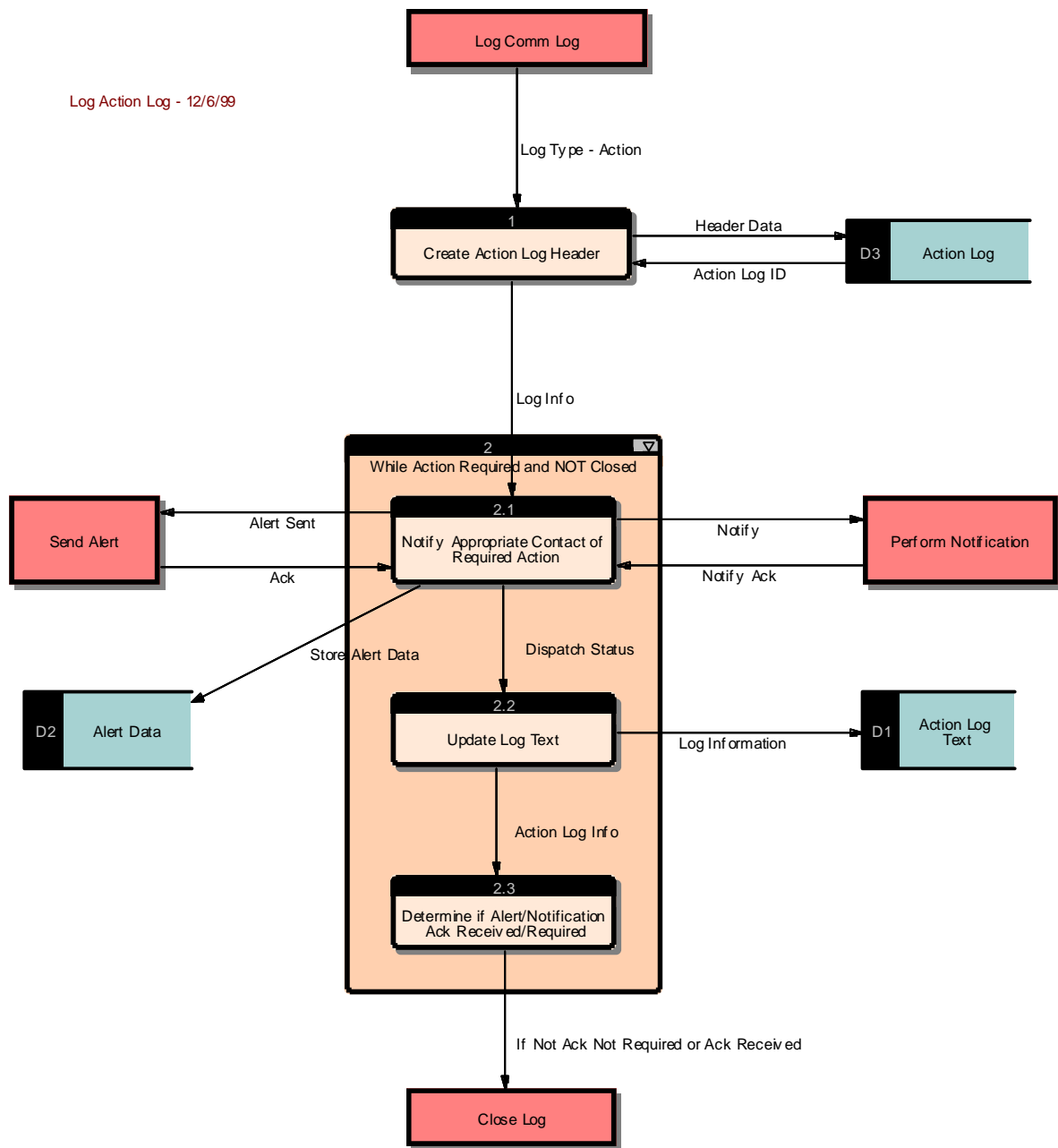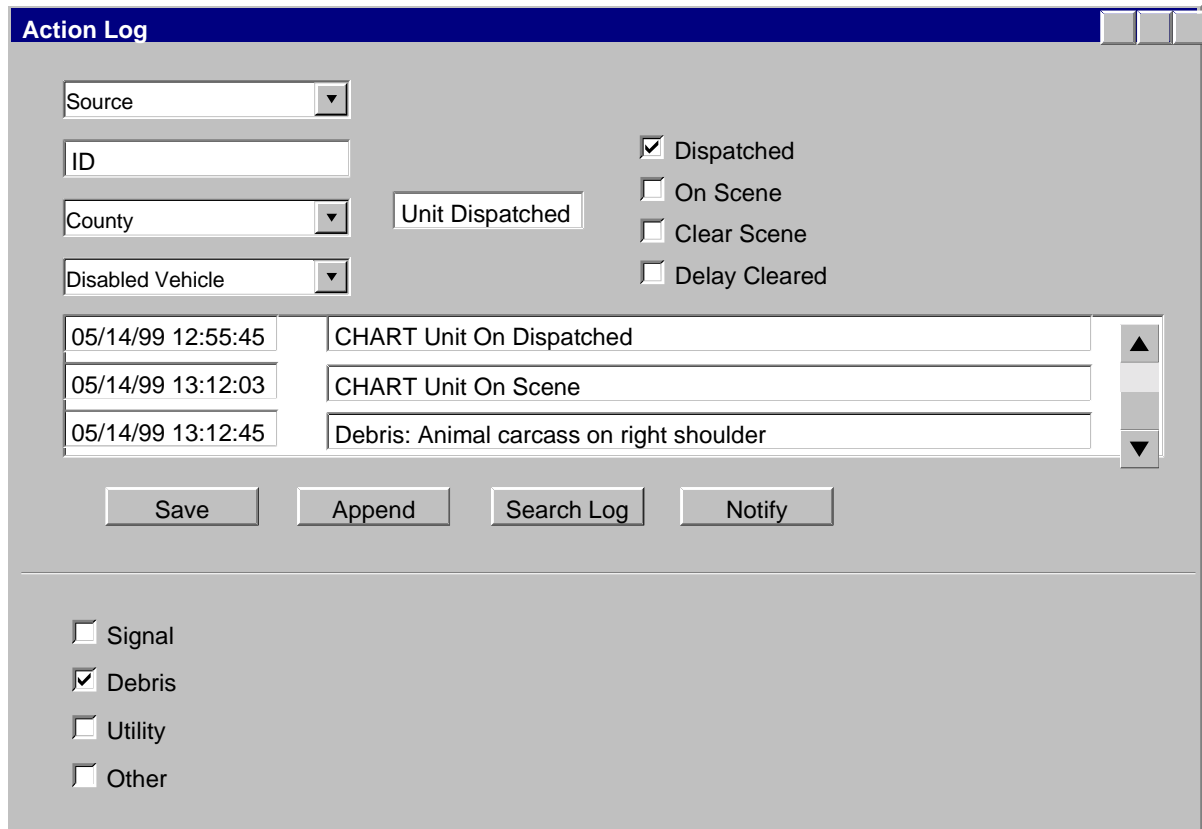
Figure 2-40. Log Action Log

A prototype Actions Log screen as discussed in the workshops is illustrated below. Process design workshop notes related to the action form are as follows:

1. The action log will be similar to the disabled log, except it will have check boxes for signal, debris (not in travel lanes), and utility.

2. The action log will have a button for Notify that will bring up the fax/e-mail list. The persons and agencies selected on the fax/e-mail list will be sent a copy of the action log via the appropriate media.

Figure 2-41. Prototype Actions Log Screen

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2.2.4.3.1.3   Log Disabled Vehicle Log

The Disabled Vehicles Log process provides the user with the capability to record appropriate information for communications received about disabled vehicles requiring assistance and the actions taken to assist the affected motorist(s). Information relating to the make and model of the disabled vehicle and the license plate number are radioed from the field and recorded in the log as a safety measure for the driver. Information from the responding unit, if equipped with AVL, may be inserted into the log by the system. This log may be operator or system initiated.
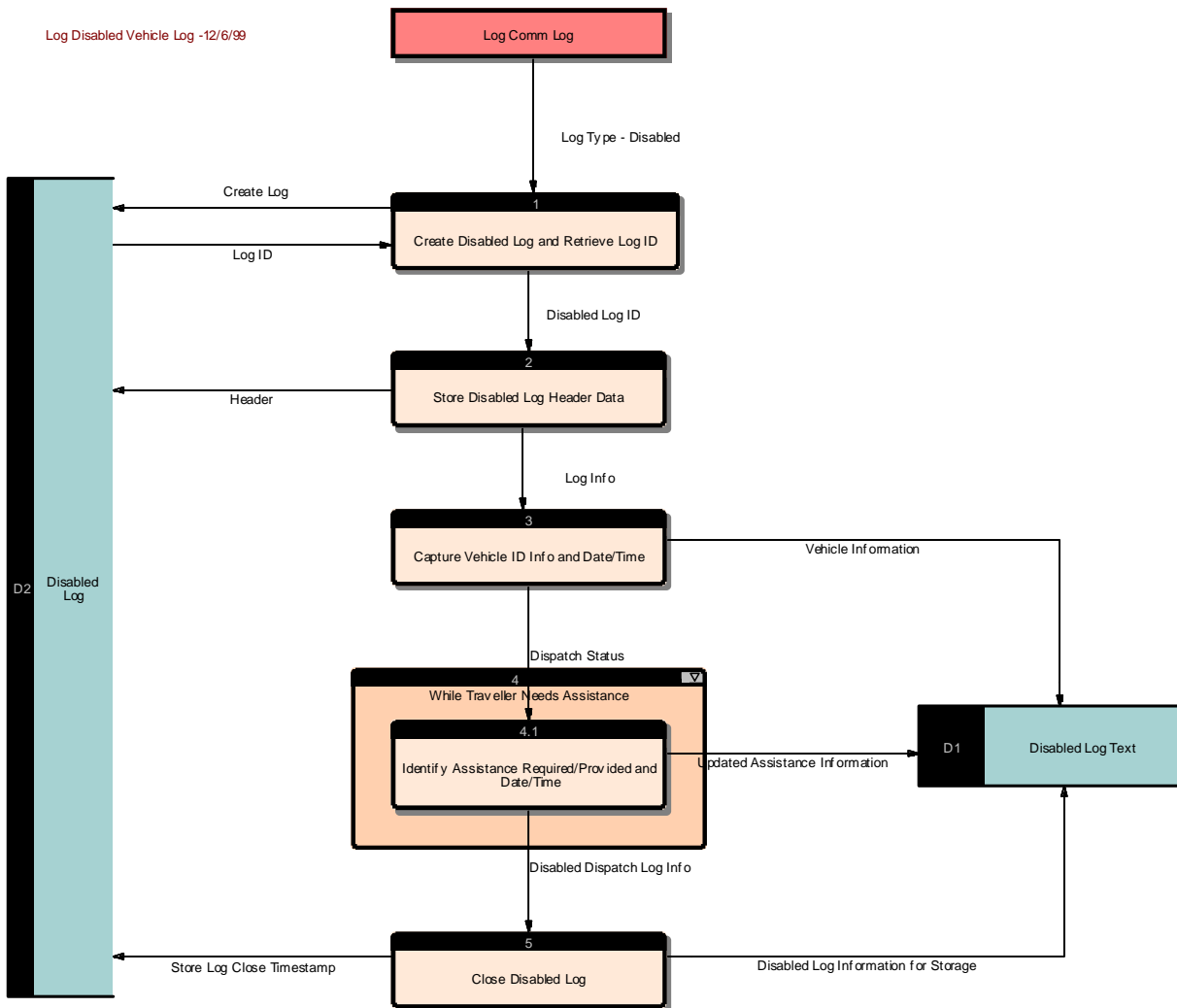
Figure 2-42. Log Disable Vehicle Log

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A prototype Disabled Vehicle Log screen as discussed in the workshops is illustrated below. Early in the process, identification information about the Disabled Vehicle and specific location information should be captured – this is to ensure the safety of the SHA vehicle driver. This is radioed in when an SHA vehicle arrives on the scene and includes vehicle license plate number and specific location such as route, direction, mile marker, lane or shoulder, etc.

Check boxes indicate the types of services performed and need to be captured to calculate metrics. This should be designed so that input can come directly from field units via AVL or manual entry.

Figure 2-43. Prototype Disabled Vehicle Log

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2.2.4.3.1.4 Log Incident Log

The Incident Log process provides the user with the capability to record appropriate information for communications received about traffic incidents. This includes:

- Time and Lane-Level Location of Incident

- Type of Incident

- Weather Conditions

- Agencies notified

- Agencies Responded

- Traffic Flow and Queue Data

- FITM Response

The incident log may have a sub-type of Roadwork if it was created as a response to the activation of an EORS permit. As information pertaining to the incident is gathered, it may be necessary to elevate the incident to a FITM incident. Once this occurs, the system allows for the display of pertinent FITM detour information. Information from the responding unit, if equipped with AVL, may be inserted into the log by the system. This log may be system or operator initiated and may contain information recorded from other system devices.
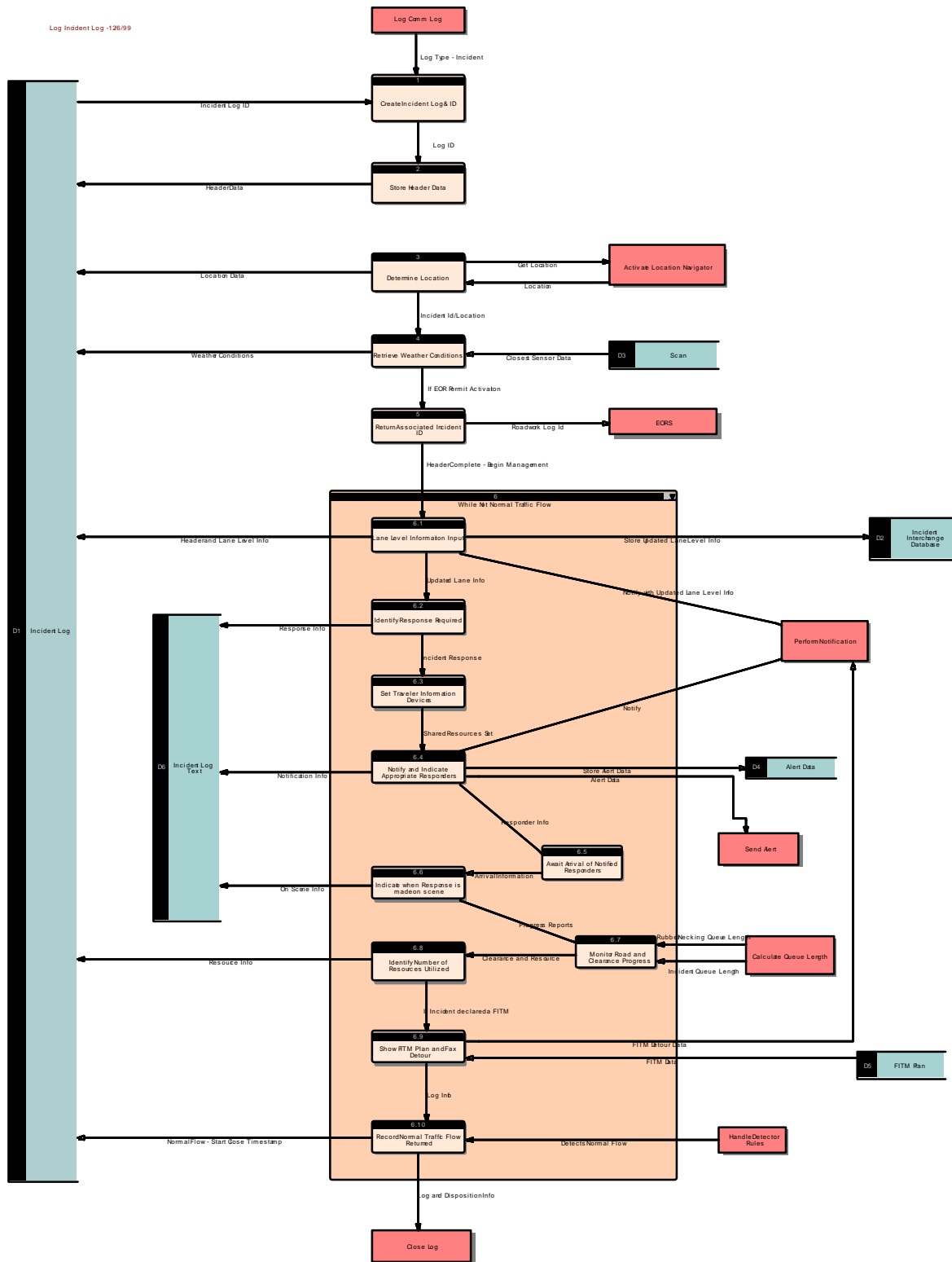
Figure 2-44. Log Incident Log

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A prototype Incident Log screen as discussed in the workshops is illustrated below. Other clarifications derived at the workshops include:

1. Incident Types (in order of preferred list sequence) are:

    - Disabled in Roadway

    - PI – Personal Injury

    - PD – Property Damage

    - F – Fatality

    - Debris in Roadway

    - Roadwork

    - Vehicle Fire

    - Maintenance

    - Signal Call

    - Police Activity

    - Off Road Activity

    - Declaration of Emergency

    - Weather

    - Other

2. Hazmat is an attribute of an incident, not an incident type

3. Road opened time stamp needs to be captured

4. Roadway location graphic needs to show on/off ramps or collection lanes

5. 'Vehicles Involved' needs to capture number of vehicles and types

6. Form needs a section to flag 'Special Needs' – such as Hazmat, Medevac, signals, etc.

7. Weather will be a drop box for R1B1, expect to be auto-populated in future releases

8. 'Resources' section needs to show type and number of units used on site for the incident

9. List of 'Resources' needs to have FITM added, and change 'ETP' to 'ETP/VRT' (VRT is MdTA Vehicle Recovery Tech)

10. Text area is for recording of which devices were activated and what was changed. Manual entry in R1B1, expect to auto populate based on incident plans as well as manual entry in future releases.

11. Only Entry Tab expected for Release 1, other tabs to be defined in future releases.

12. Data/Time Stamp at top is to reflect when the related Incident record is created, not when the form is opened.

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13. Special Needs section from SHA Incident Report Form (designated SHA.52.4-1) to be included on the Incident Log

14. Dispatched, On Scene, Clear Scene, and Delay Cleared are added to the incident log.

15. There needs to be a way to determine when the normal traffic flow has resumed. One suggestion is when the last device is returned to normal time of day operation.

16. Clicking to open/close a lane will also place text in the log with a date/time stamp.

17. In the Vehicles Involved section, there must be a way to have sub-categories, such as,

   ❑ Tractor-Trailer

      • Jack-knifed

      • Overturned

      • Lost Load

18. When a camera is selected to verify or monitor an incident, the camera used should be noted in the log. User should be able to identify when camera coverage of the incident location was unavailable.

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Figure 2-45. Prototype Incident Management Log Screen

2.2.4.3.1.4.1   View Historical vs. Current

The View Historical vs. Current process provides the operator the capability of viewing a display of detector data for the area of an incident. The operator may select one or more detectors in the area and a time frame. The system will plot and display a comparison of historical data and current data for these detectors over the selected time period. From this data display, the operator will be able to discern information as to the severity of the blockage compared to 'normal' traffic flow for the time period, and determine when traffic flow is restored to 'normal' conditions.

View Historical Vs Current Data (Detectors) - 9/9/99
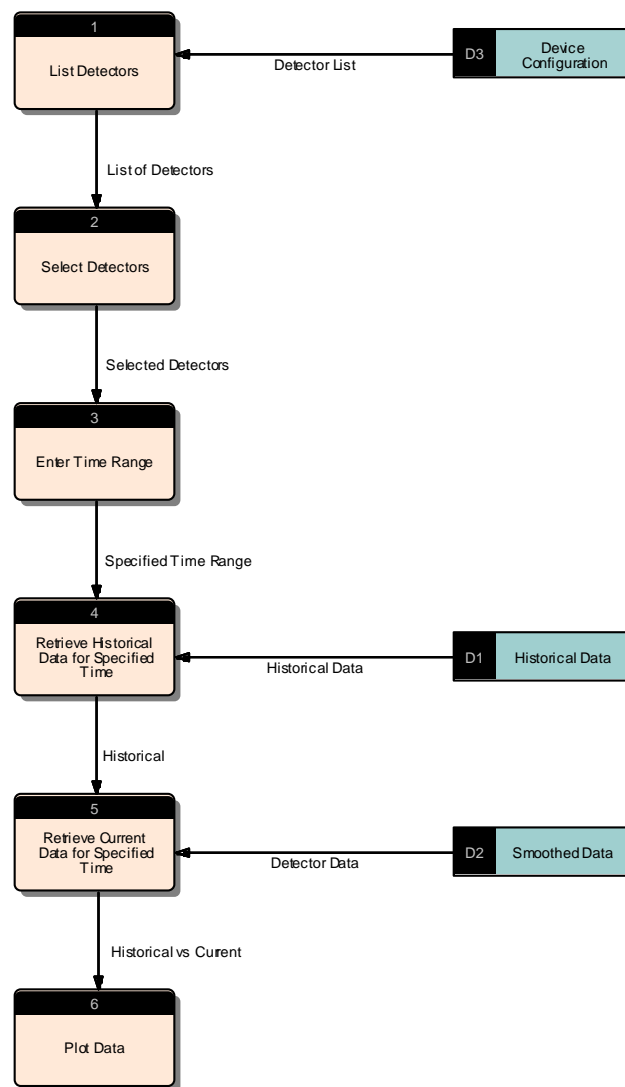
Figure 2-46. View Historical Vs. Current

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2.2.4.3.1.5   Log Congestion Log

The Congestion Log provides the user with the capability to record appropriate information relating to *non-recurring* congestion. When the system determines that there is congestion and creates a *congestion response plan*, all information pertaining to that response is stored in a congestion log. A system generated congestion log can be closed when the system determines that the roadway is no longer congested. This process is operator or system initiated.
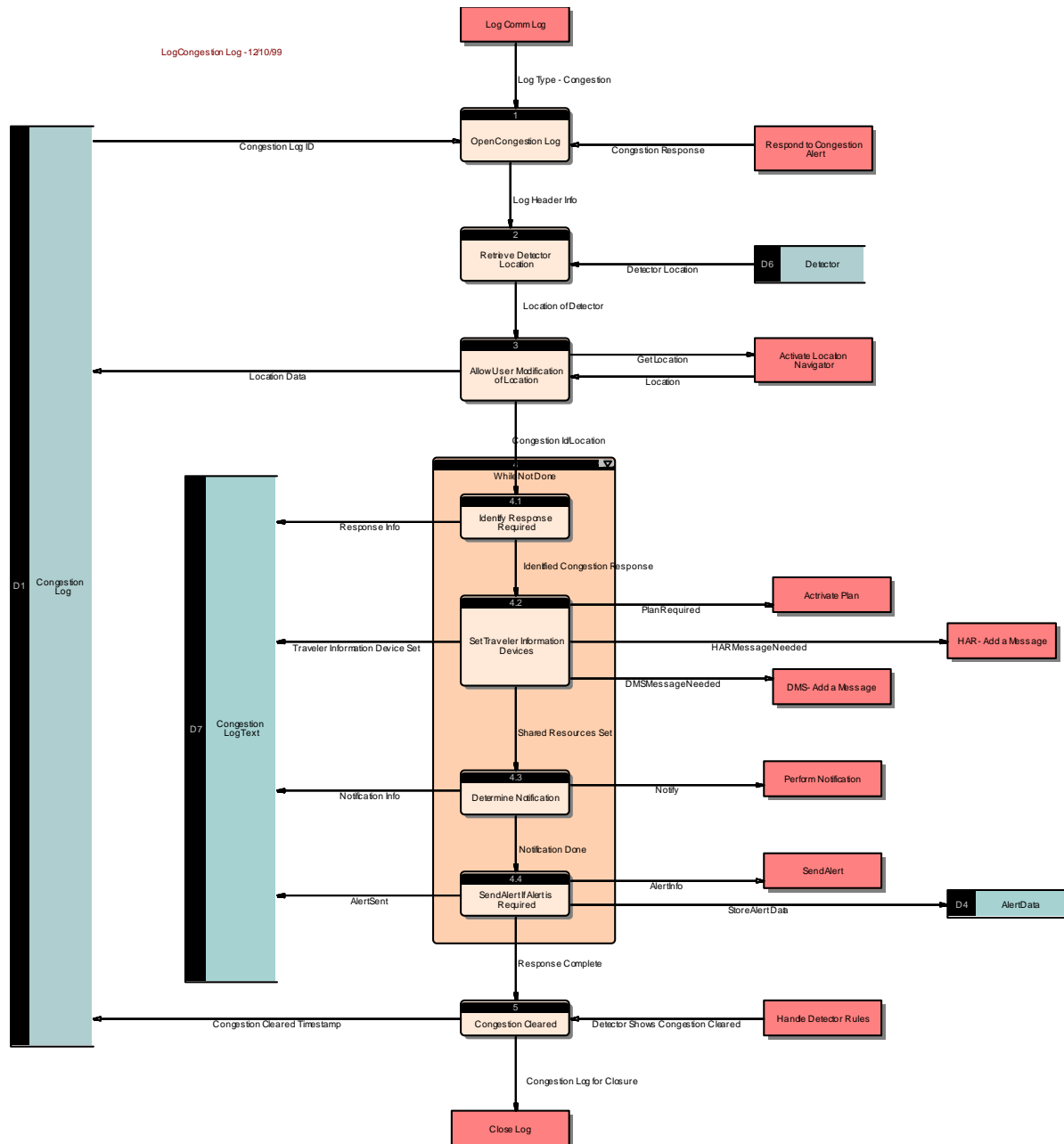
Figure 2-47. Log Activity Log

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2.2.4.3.1.6   Log Recurring Congestion Log

The Recurring Congestion Log provides capabilities for operators or the system to record actions taken in the management of *recurring* congestion. It is expected that recurring congestion conditions will be managed by activating a scheduled event at predetermined time periods. The system will initiate a recurring congestion log at the start of a scheduled event identified for recurring congestion. If initiated by the system, an operator may insert actions taken as appropriate, or may revise the scheduled messages and have those actions recorded in the log by the system. An operator may initiate and manage a recurring congestion condition by initiating a log and taking appropriate actions.
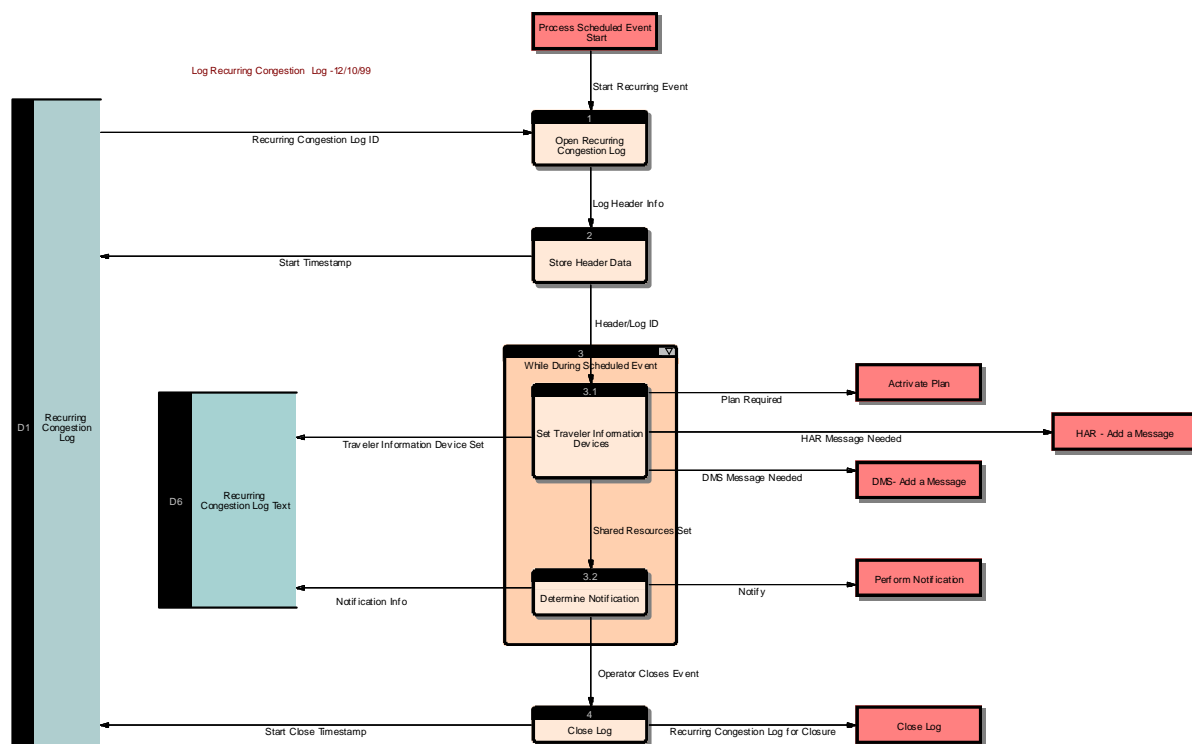
Figure 2-48. Log Recurring Congestion Log

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2.2.4.3.1.7 Log Special Event Log

The Special Event Log process provides capabilities for operators or the system to record actions taken in the management of special events. It is expected that recurring special events will be managed by activating a scheduled event at predetermined time. A special event log may also be initiated by an operator and manually managed. Manual alerts may be sent regarding the special event. All shared resources used and notifications performed are logged. If initiated by the system, a special event log will be closed at the end of the scheduled event, or it may be closed by the operator, which will force the end of the scheduled event. If initiated by an operator, the special event log will have to be closed by an operator.
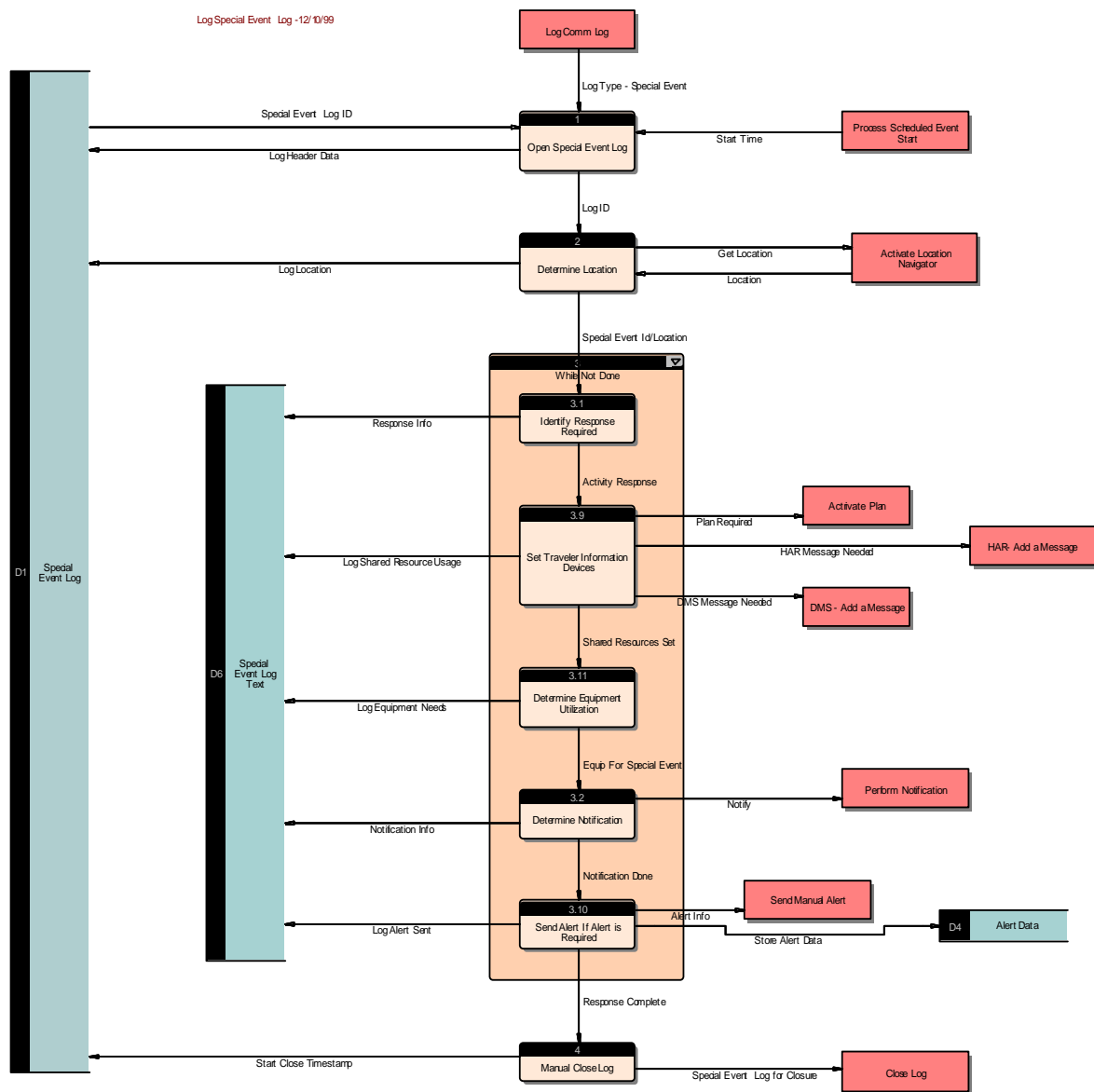
Figure 2-49. Log Special Event Log

2.2.4.3.1.8   Log Weather Advisory Log

The Weather Advisory Log process provides the user with the capabilities to manage and record appropriate information and actions taken pertaining to National Weather Service alerts. All traveler information devices used are logged. Manual alerts sent and notifications performed are also logged. This process is operator initiated and closed.
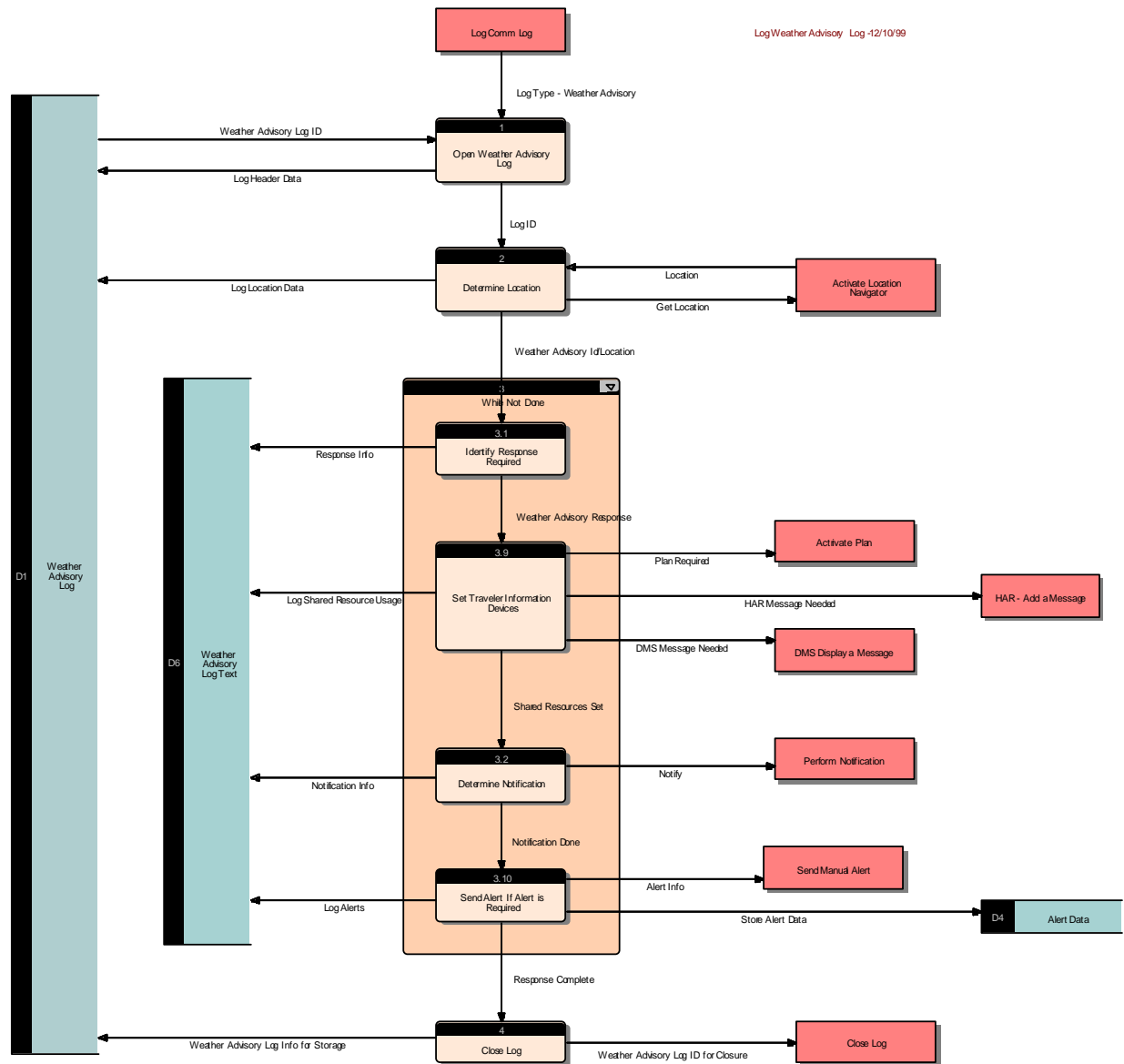
Figure 2-50. Log Weather Advisory Log

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2.2.4.3.1.9   Log Weather Sensor Log

The Weather Sensor Alert Log process provides capabilities to record information pertaining to inclement weather detected by the weather sensor devices and the response actions taken to manage the situation. This log is initiated when data from the weather sensor devices are evaluated against thresholds and found to be non-normal, and a weather sensor alert is generated. A response plan for the weather sensor alert is created and, if operator approval is requested and received, the response plan is executed. All traveler information devices used to notify the public of the current weather conditions is logged. Notification performed and manual alerts sent are also recorded. This process is system initiated and will be closed by the system when data from the sensors reflect normal conditions. This log may also be closed by an operator, which will force the deactivation of the response plan and should disable sensor detection for some operator-specified period of time.

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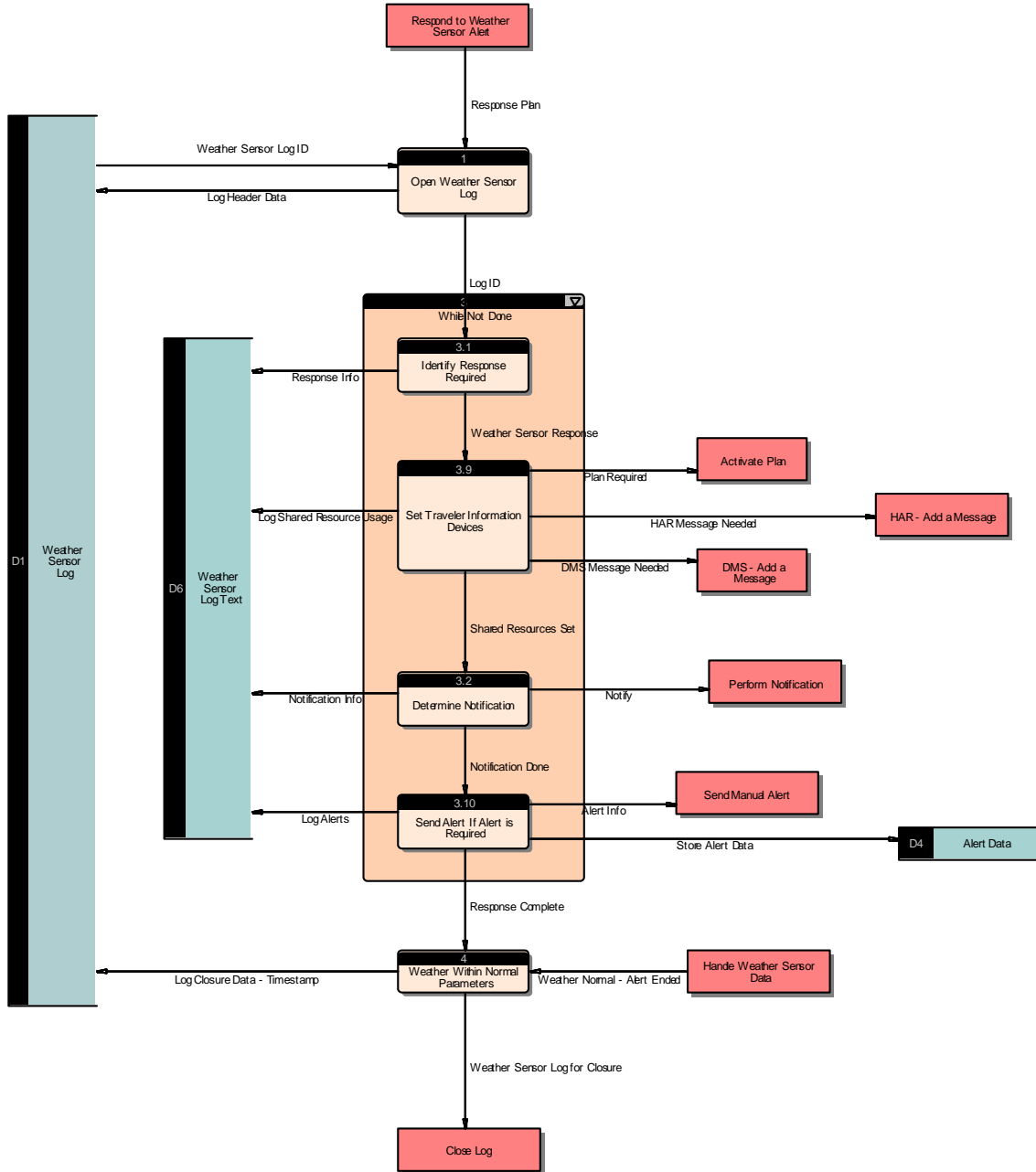
Figure 2-51. Log Weather Sensor Log

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2.2.4.3.1.10 Log Safety Message Log

The Safety Message Log process provides the capabilities of recording appropriate information pertaining to the display and/or broadcasting of safety messages. Safety messages can be set for display using the scheduler, in which case the system will initiate the safety message log. This log can be operator initiated and messages may be displayed or broadcast by activating a safety plan or manual selection of devices. All traveler information devices used are logged. If system initiated, this log will be closed at the end of the scheduled event. An operator may also close this log before the end of the scheduled event, which will force the early closure of the scheduled event. If operator initiated, an operator must close the log.
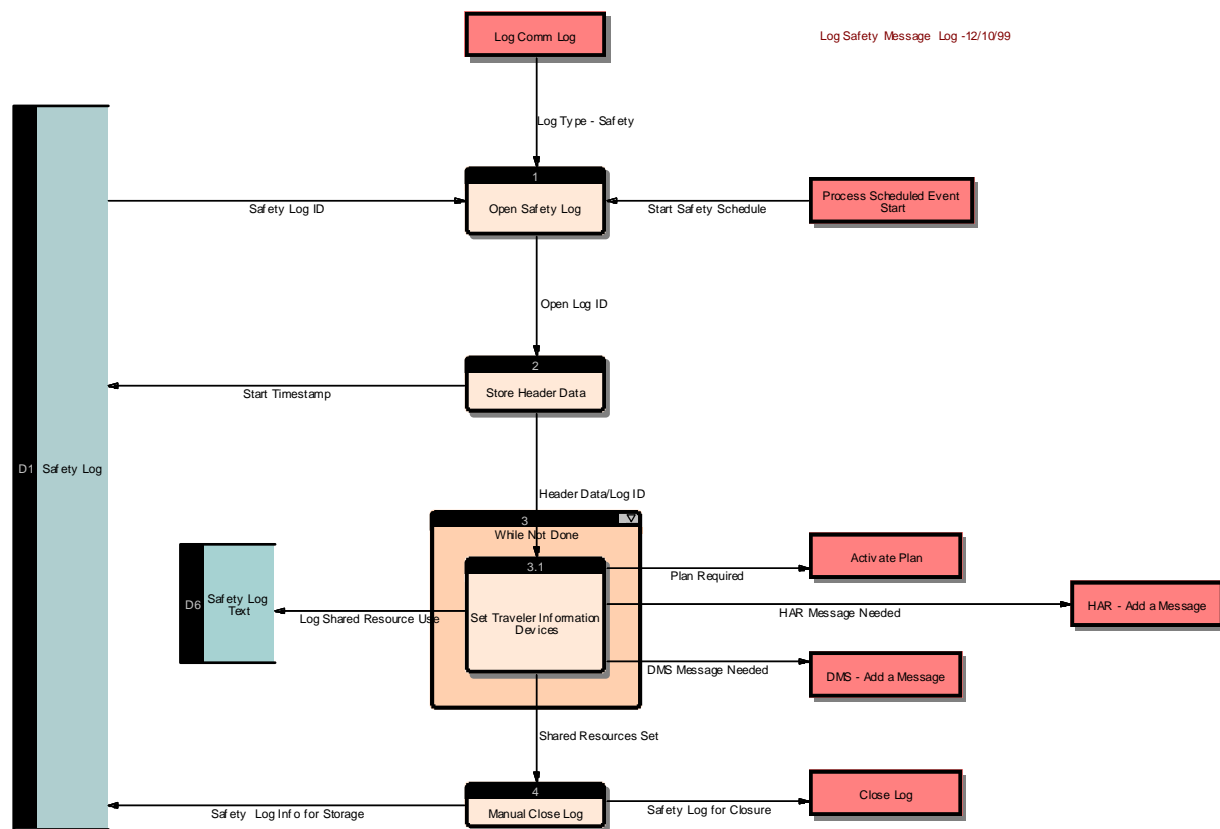
Figure 2-52. Log Safety Message Log

2.2.4.3.1.11 View Log

The View Log process allows an operator to select and view all information relating to the selected log including start/end timestamp, operator and system generated actions, and response data. This view of a log must be capable of displaying all log data and to include data captured under various log types during the progression of the life of the log.

View Log - 12/6/99

Figure 2-53. View Log

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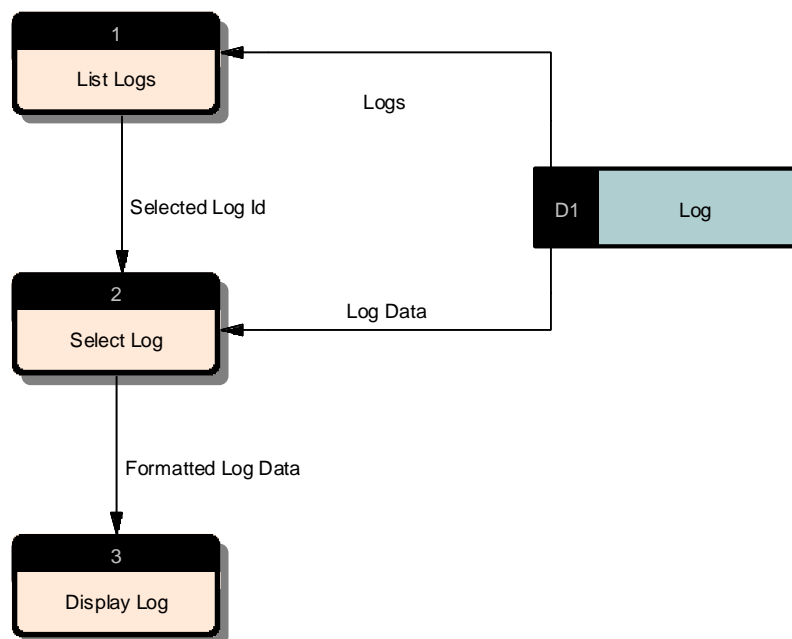
2.2.4.3.1.12 Close Log

The Close Log process stores appropriate information about the closure of the incident and activity logs, releases shared resources (DMS and HAR) related to the log, and initiates the sending of notifications to appropriate personnel and organizations. If an incident log was related to road construction (an EORS permit), closure information is sent to the EORS system. Two closure date/time stamps are maintained for logs. One is the time the operator or system indicates that the situation is restored to normal; the second is when the system completes all of its closure activities.

Closure may be operator or system initiated. Detector or sensor data may indicate the end of a traffic or roadway situation and initiate closure of a related log. Operators may close a log when the roadway is restored to normal traffic flow or the situation being managed is over.

Detector and sensor processing may not close a log that was initiated by an operator.

CHART II Business Area Architecture Report   118   August 23, 2000
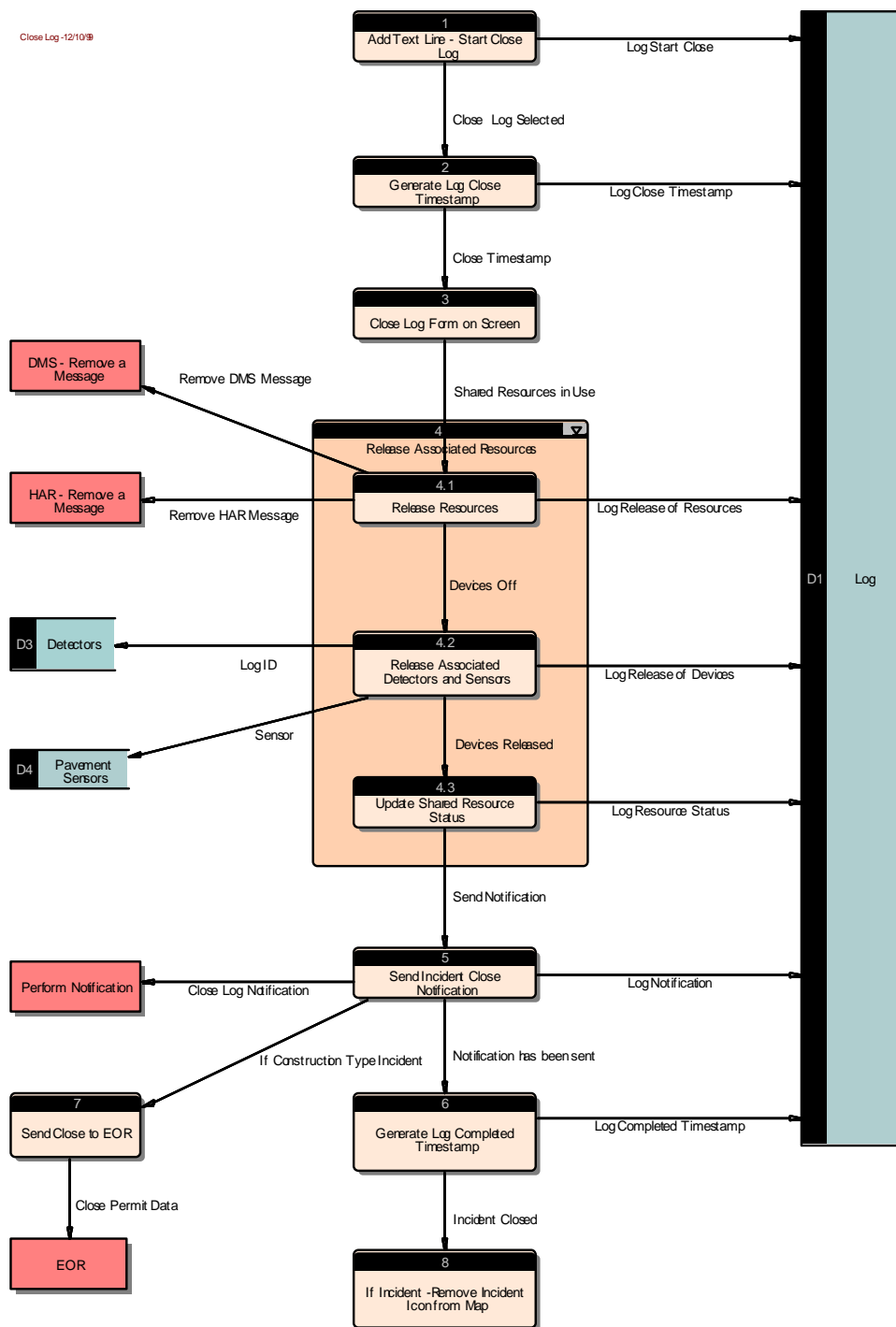
Figure 2-54. Close Log

2.2.4.3.2 Location Navigation

The Location Navigation processes are intended to provide operators with a tool to aid in pinpointing the location of an incident for entry on the Incident Log. This is accomplished by building a database of map coordinates for landmarks, exits, intersections, etc. for each highway. This provides a user interface allowing the user to search and select appropriate information in the database and position a cursor on a map display based on the stored map coordinates. The operator should be able to move the initial cursor position to better match the received information (*ex:* 1000 yards north of Exit 12, second lane) and then indicate that this is the position recorded in the Incident Log.

2.2.4.3.2.1 Maintain Location Navigation Data

The Maintain Location Navigation Data process provides the capabilities to build and maintain the database of map coordinates for landmarks, exits, intersections, etc. for each highway. Map coordinates need to be easily recorded for each item to match the CHART map system.
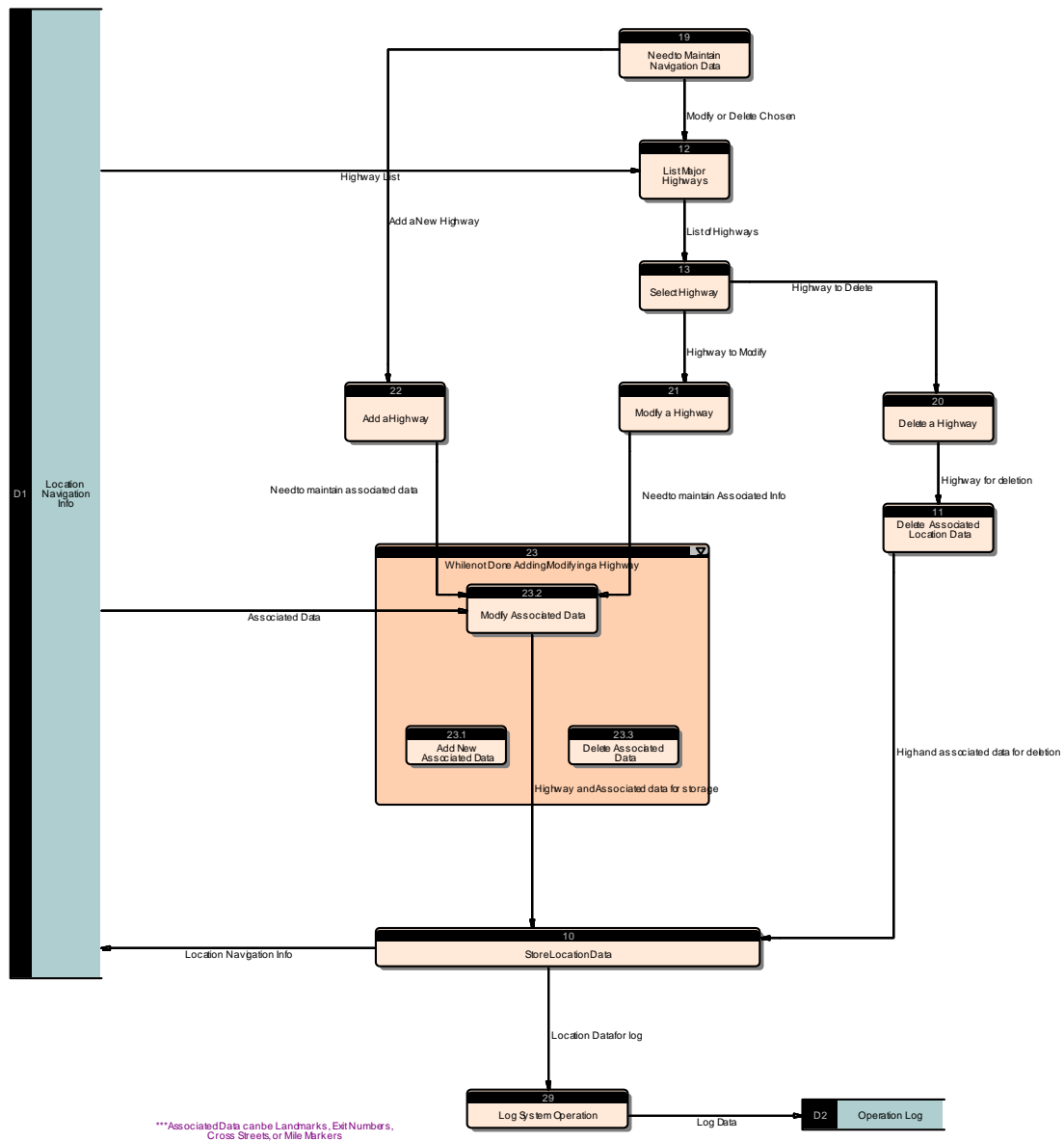
Figure 2-55. Maintain Location Navigation Data

2.2.4.3.2.2 Activate Location Navigator

The Activate Location Navigator process is activated from the Incident Log. This process allows the operator to select the highway where the incident is located and then displays a list of associated data (landmarks, exits, intersections, etc.) for that highway. Additionally, the location of CHART vehicles as identified by the AVL devices should be available for the operator to select to identify the location. The operator selects a landmark, exit, intersection, or AVL from the list and the system displays a movable cursor on the map indicating the location of this item. The operator manipulates the map zoom levels and the cursor to pinpoint the appropriate road segment. When satisfied with the position, the road segment is captured and displayed on the Incident Log, Disabled Vehicle Log, Congestion Log, or Action Log.

Implementation Considerations: this process is critical to saving operator data entry time and there is much interest in its implementation. Prototyping this process with the SOC operators should be planned for.

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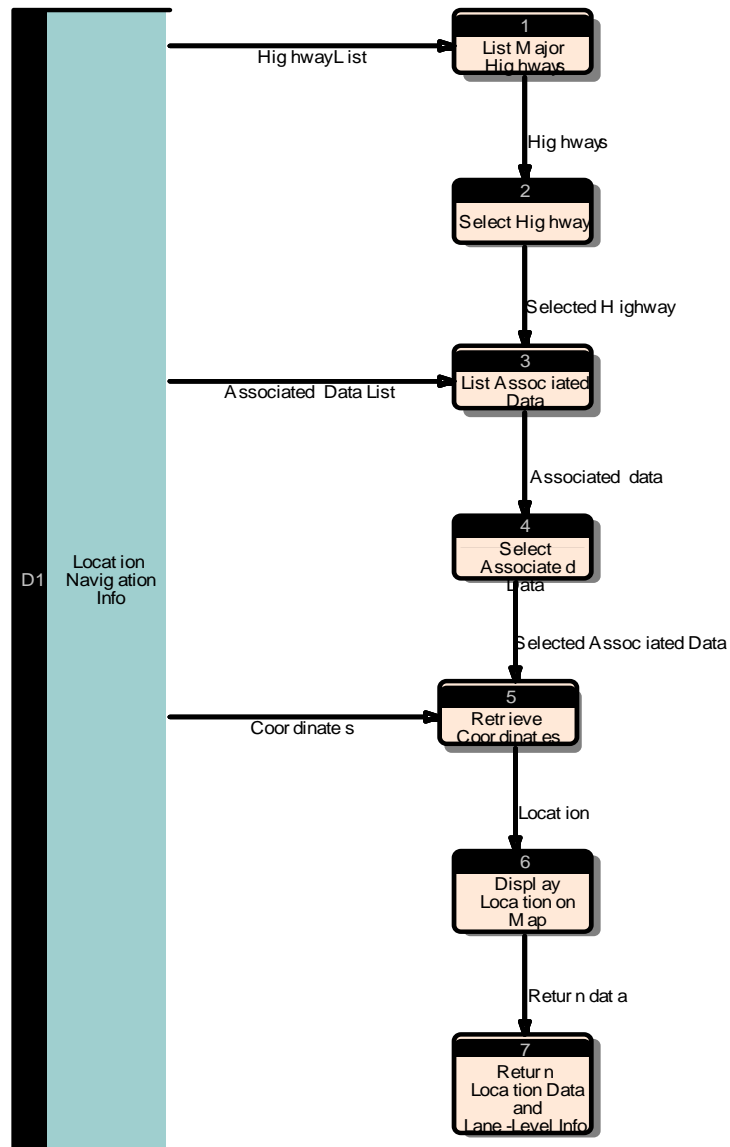
Figure 2-56. Activate Location Navigator

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2.2.4.3.3   Queues

The Queues process group contains a single process that calculates or records queue lengths related to a specific Incident Log. This process aids the operator in providing queue length information required on the Incident Log.

2.2.4.3.3.1   Calculate Queue Length

The Calculate Queue Length process either calculates queue lengths based on detector data or provides operators with a means to manually enter queue length data. Two types of queue lengths are calculated for each Incident Log: in the direction of the roadway having an incident, and in the opposite direction due to 'rubber-necking'. Where multiple detectors are installed along the roadway, detector data will be evaluated to determine the length of the queue in each direction and displayed on the Incident Log. Where only one detector is available downstream from the incident (either direction), the queue length will be calculated to that detector and captured and displayed on the Incident Log. This process will have the capability for the operator to enter data and override the calculated queue length, or to record a queue length when no detectors are available.

Once activated by the operator – *and until overridden* – the queue length will be periodically updated based on the frequency of polling of detector data.

CHART II Business Area Architecture Report   124   August 23, 2000
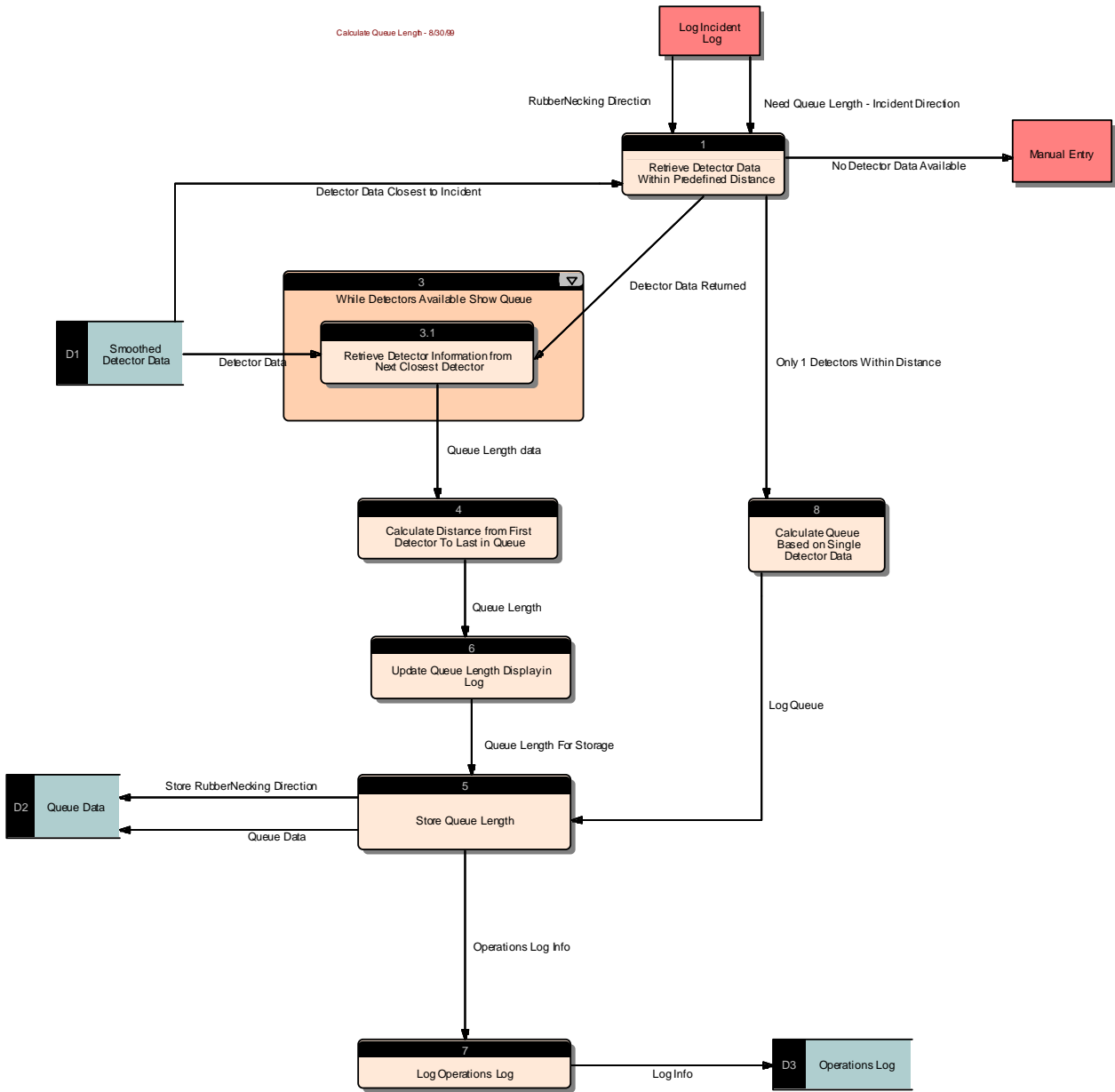
Figure 2-57. Calculate Queue Length

2.2.4.3.4   Notification

The Notification process group includes those processes necessary to maintain a list of individuals to be notified when specific actions/activities are processed in the system. It also contains the capabilities to determine which individuals are notified for which system actions and by which method. Methods of notification include Fax, E-Mail and Paging.

2.2.4.3.4.1   Maintain Notification List

The Maintain Notification List process maintains a database of groups of individuals or organizations to be notified, their method of notification (and the details for accomplishing that method), and those system processes/functions for which they are to be notified. The database and maintenance capabilities will be designed to support the following:

- Maintenance of groups

- Maintenance of individuals or organizations and the necessary data for performing the Fax, E-Mail or Paging notification for each individual or organization

- The capability to assign individuals or organizations to one or more groups

- The capability to assign one or more groups to specific system processes or functions which require a notification capability
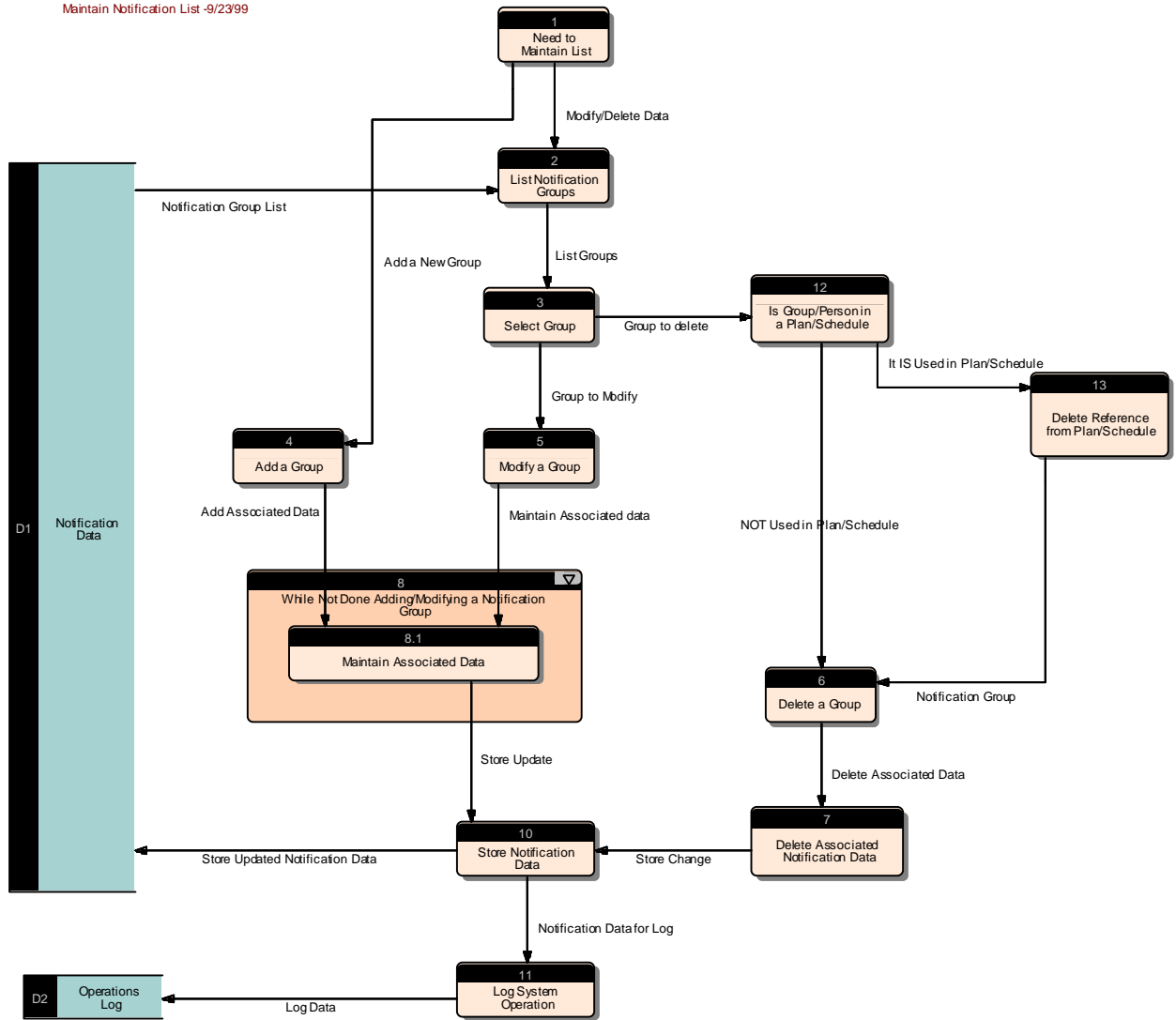
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Figure 2-58. Maintain Notification List

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2.2.4.3.4.2 Perform Notification

The Perform Notification process is activated from other system processes. The process receives type of notification and notification-specific information from these other processes. Based on the type of notification, the specific group(s) is selected. A notification is formatted for the method to be used for that individual or organization in the group(s). Based on the method of notification, *notification-specific* information and *method-specific* information is passed to the appropriate supporting COTS application that performs the actual transmission and return a success or failure result. If the notification is related to a Log, individual level notification successes and failures are recorded in the related Log. Individual level notification successes and failures are recorded in the Operations Log.

For the Incident Log, media and private-sector traffic information services are advised of current incidents through their querying of the Incident Interchange Database. This Perform Notification process could also provide additional notification.
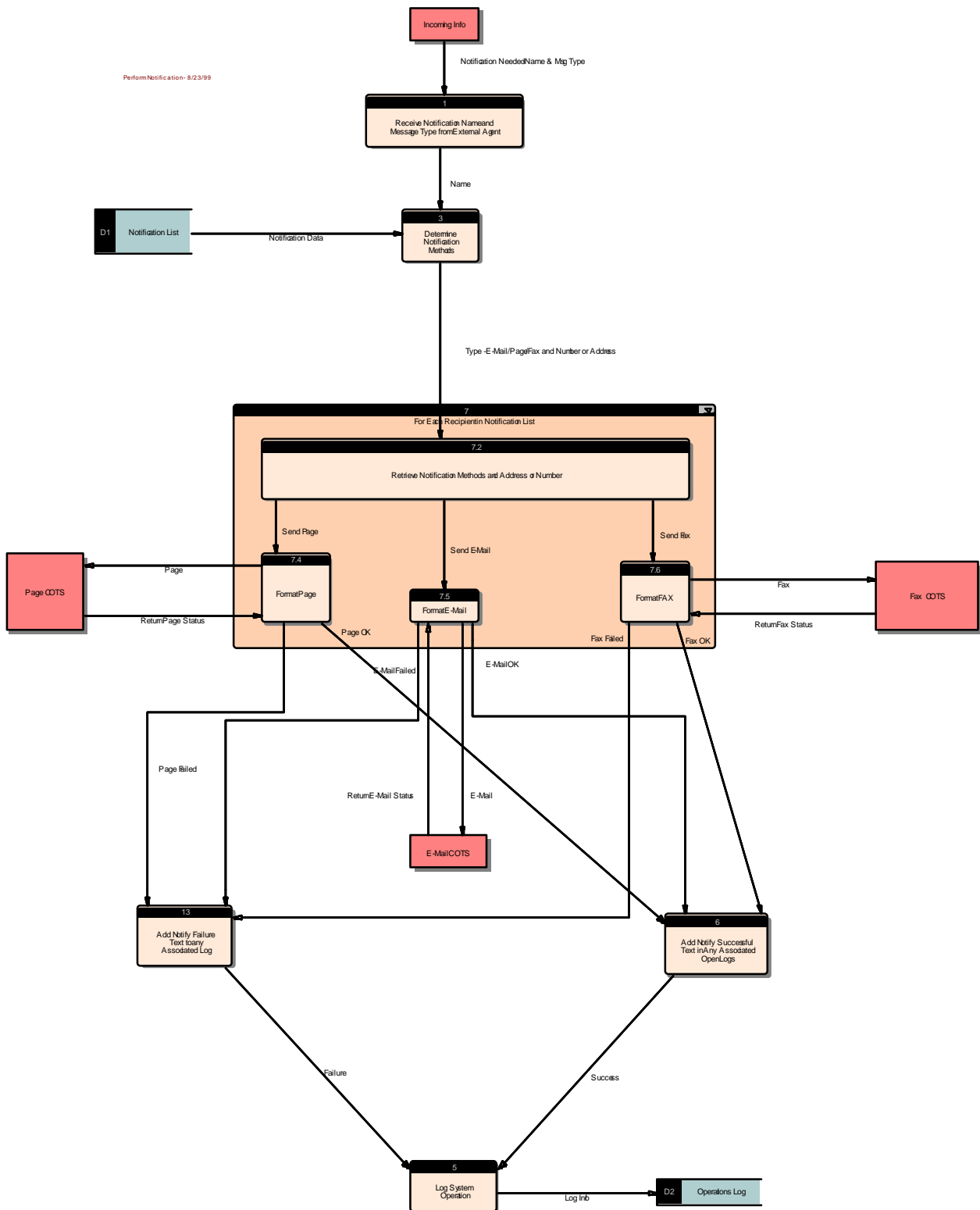
Figure 2-59. Perform Notification

2.2.4.4 Shared Resource Management

The Shared Resource Management processes include all those processes necessary to define, setup, and control the monitoring, verification, and traveler notification aspects of the CHART II system. These processes are divided into groups related to DMS, HAR, AVCM, Detectors, Equipment, Signals, and AVL. The following figure identifies the individual processes within each group.

CHART II Business Area Architecture Report 130 August 23, 2000
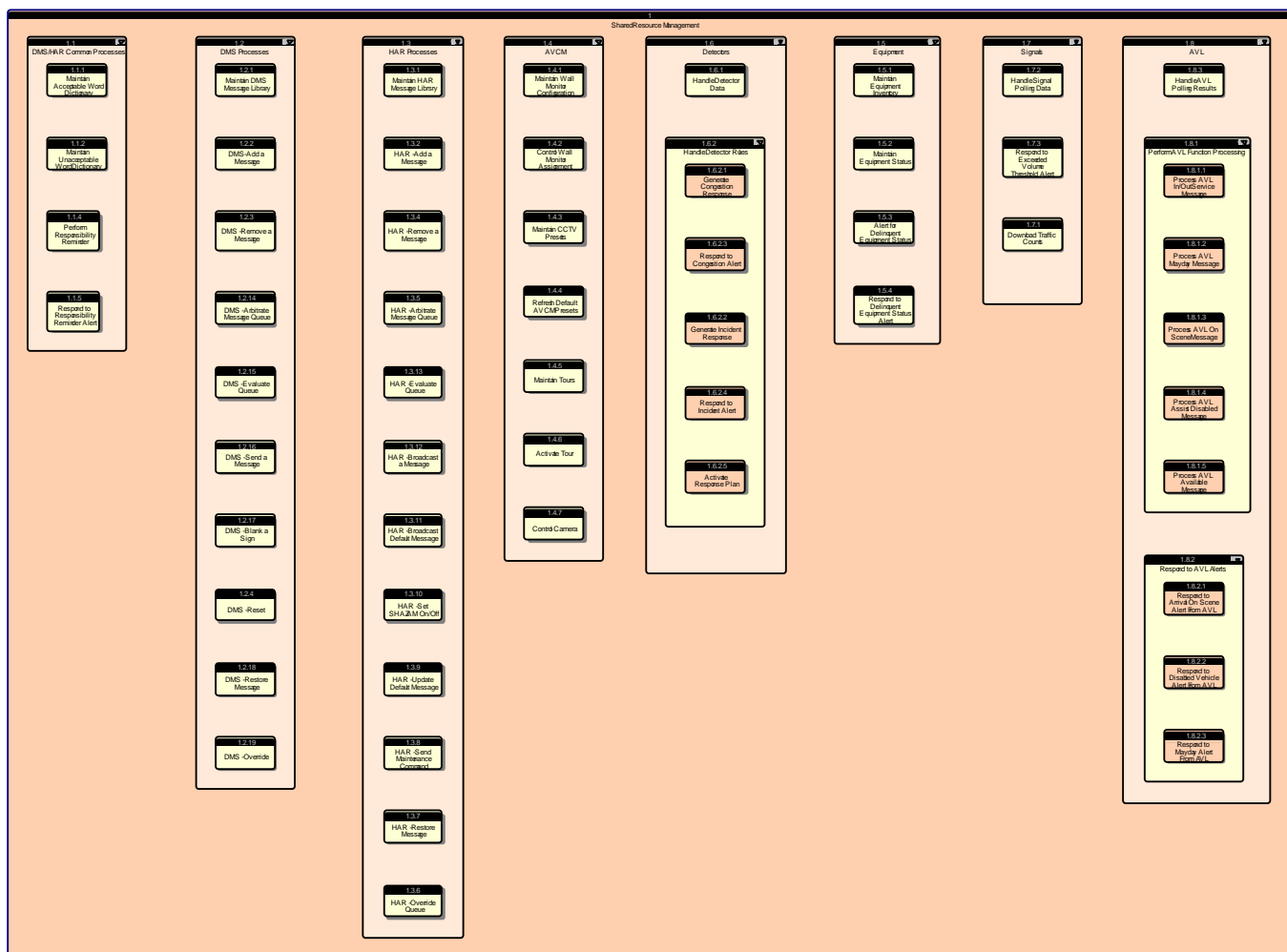
Figure 2-60. Shared Resource Management

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DMS and HAR device processes include message arbitration processes which maintain a message priority queue for each DMS and HAR device and determines which message is to be displayed or broadcast at any point in time. In the default state, each device will be blank or broadcasting a default message and its queue will be empty.

As messages are requested for display or broadcast on a specific device, they are added to that device's queue. Based on priorities, the highest priority message that exists for a device is displayed or broadcast at all times. Any lesser priority messages remain in the queue for display or broadcast when the higher priority message(s) is de-activated.

Messages in the queue are related to specific logs. Any one log will have only one message in a device queue at any one time.

Messages are de-activated in the queue when a blank command is sent to the device from the related log. If the highest priority message in the queue is blanked, the next highest is displayed or broadcast. The blanking of all messages in a queue makes the queue empty and the last message blanked causes the device to be set to its default state.

A scheduled message is placed in its appropriate level in the queue upon scheduler event activation start-time and removed upon scheduler event end-time and displayed or broadcast whenever it is the highest priority in the queue.

Message priorities are to be based on system parameters so that changes in the priorities may be effected without re-coding. Per workshop discussions, the following sequence of message priorities were agreed to as a starting configuration for DMS devices:

Sequence	Message Type	Operator/System Control
1	Incident	Operator
2	Incident	System
3	Roadwork	Operator
4	Congestion	Operator
5	Weather Alert	Operator
6	Special Event (High Priority)	Operator
7	Recurring Congestion	Operator
8	Congestion	System
9	Weather Alert	System
10	Special Event (Low Priority)	System
11	Recurring Congestion	System
12	Safety Message	Operator
13	Safety Message	System
14	SHAZAM (DMS only)	Operator
15	SHAZAM (DMS only)	System

A discussion topic of the process design workshops involved allowing the display of two separate one-page messages. This would allow the alternating display of the two highest priority one-page messages. It was decided that devices will be configurable to allow: *no* multi-page messages, *two* incident related messages, or *one* incident and *one* roadwork two-page message.

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Message priorities for HAR are handled differently in that, as the broadcast time limit allows, high priority messages will be concatenated and broadcast. The queues for the HAR devices therefore act as sorters to indicate the sequence of messages to be considered for concatenation. The priorities for HAR messages should be very similar to the table shown above (excluding the SHAZAM messages) but should have their own set of system parameters to allow for variances.

2.2.4.4.1 DMS/HAR Common Processes

The following set of processes is common to both DMS and HAR devices.

2.2.4.4.1.1 Maintain Acceptable Word Dictionary

The Maintain Acceptable Words process maintains a central dictionary of words or phrases allowable in DMS (Dynamic Message Signs) and HAR (Highway Advisory Radio) messages. This dictionary is used in the validation of library or ad hoc messages for both DMS and HAR devices.

Maintain Acceptable Word Dictionary -10/6/99
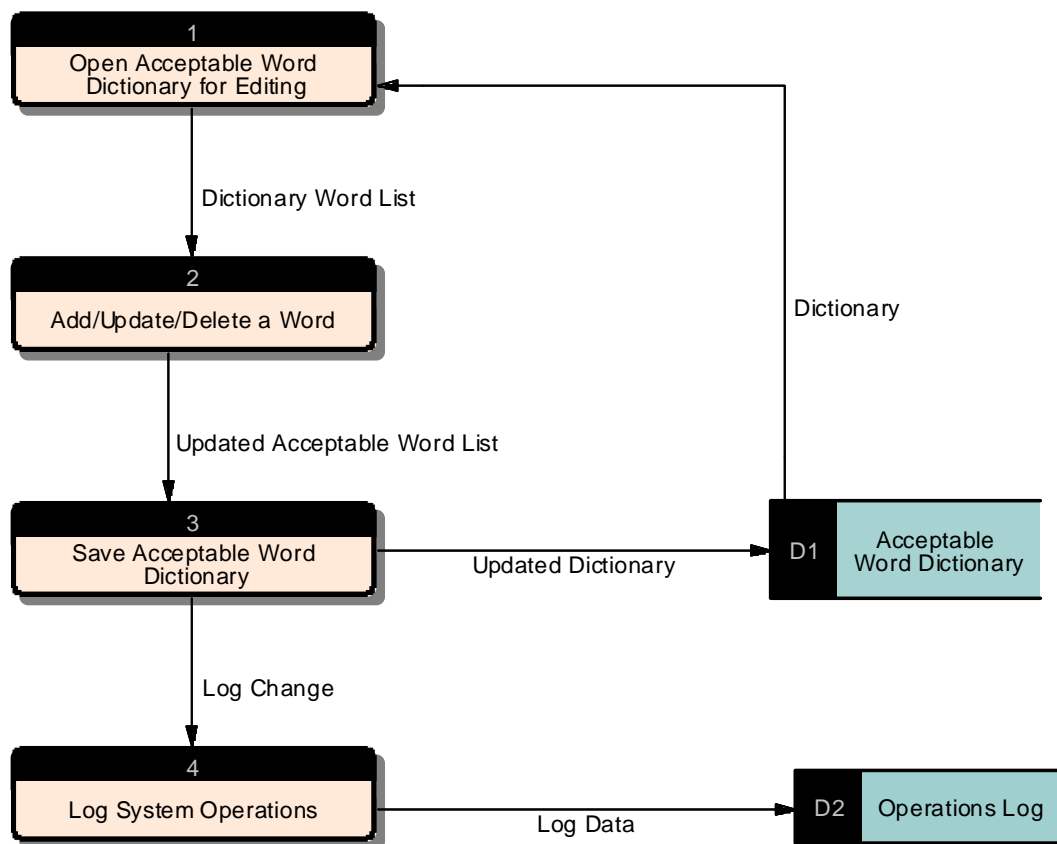
Figure 2-61. Maintain Acceptable Words

2.2.4.4.1.2 Maintain Unacceptable Word Dictionary

The Maintain Unacceptable Words Dictionary process maintains a central dictionary of words or phrases not allowed for use in DMS and HAR messages. This dictionary is used in the validation of library or ad hoc messages for both DMS and HAR devices.

Maintain Unacceptable Word Dictionary -10/6/99
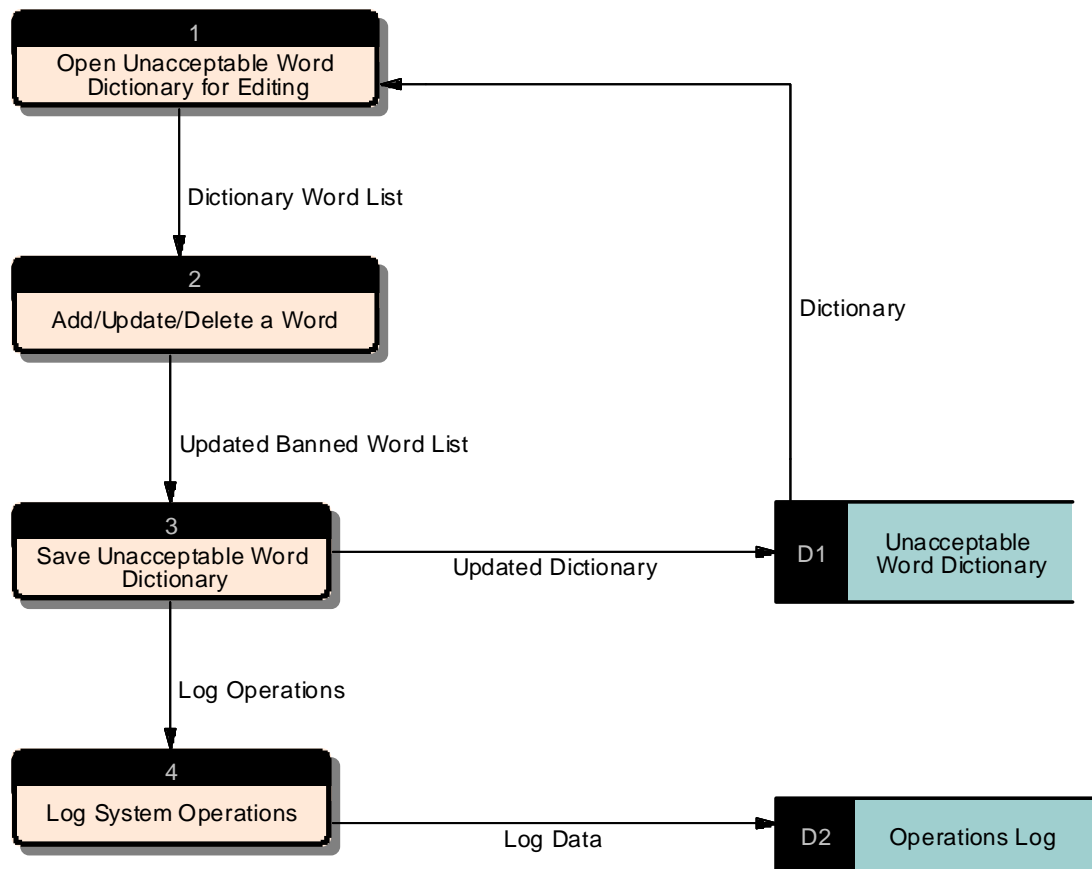
Figure 2-62. Maintain Unacceptable Words

2.2.4.4.1.3 Perform Responsibility Reminder

The Perform Responsibility Reminder process is used to notify operators at the responsible center if a log is opened past the timeframe that has been set in the system parameters. In responding to a responsibility alert, the operator may specify a different reminder timeframe for determining when to send the next alert. If the reminder alert remains unacknowledged, the alert will be escalated.

Perform Responsibility Reminder-12/6/99
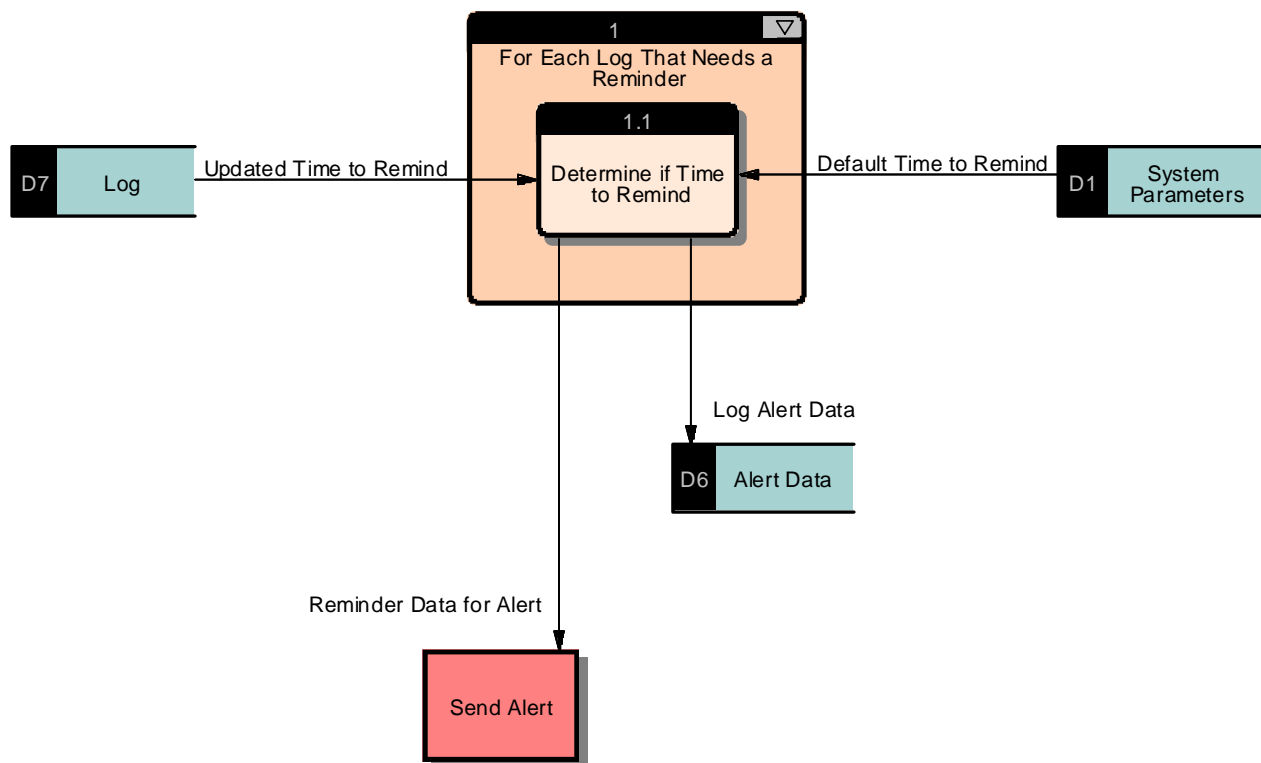
Figure 2-63. Perform Responsibility Reminder

2.2.4.4.1.4 Respond to Responsibility Reminder Alert

The Respond to Responsibility Reminder Alert process allows the person receiving the alert to either cancel the reminder and thus close the associated log, or update the reminder timing. If the user wants to update the reminder timing, there will be a place in the log to lengthen the timing so the reminder will not come up as often. Once the reminder information is updated, the information is saved and the change to the reminder timing is recorded in the Operations Log.

Respond to Responsibility Reminder Alert-12/6/99
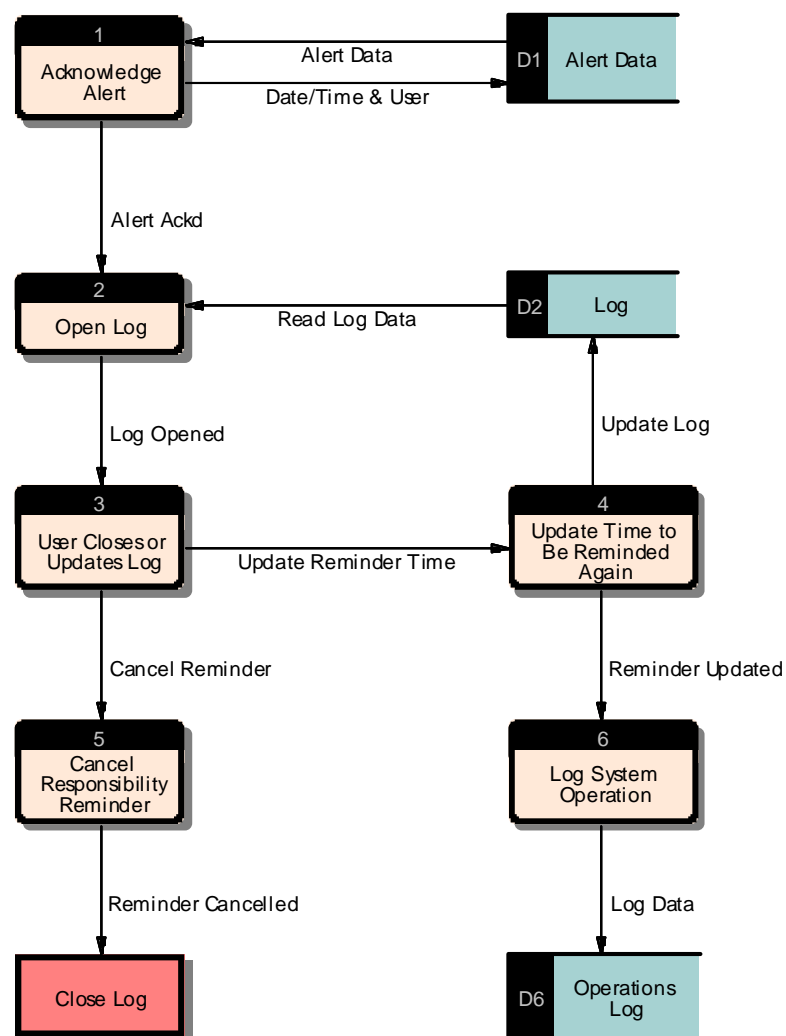
Figure 2-64. Respond to Responsibility Reminder Alert

2.2.4.4.2 DMS Processes

The DMS Processes group allows for the System Administrator to maintain the acceptable and unacceptable words dictionary for the DMS displays, as well as maintain a central message library. The CHART operators are able to display and blank messages on the DMS devices and also reset the devices as needed.

2.2.4.4.2.1 Maintain DMS Message Library

The Maintain DMS Message Library process provides for the centralized creation and maintenance of message text and beacon control for pre-defined DMS messages. The system may provide multiple physical libraries to allow organization of messages into logical topic groupings (construction, incident, events, weather, special, safety, etc), and to reduce the effort for disbursing changes to message libraries across the system.

The following information is needed for each DMS stored message:

- Message ID – The message ID uniquely identifies each stored message.

- Message Name – Each message has a name, the text for display on the DMS, and the sign length capable of displaying the message.

- Message Text

- Topic/Category – Each message is associated with a category within the library. For example, under the Weather library, messages may be categorized as Snow, Ice, Freezing Bridges, etc. The combination of library topic and message category provides the means to organize messages when displayed in the navigator.

- Sign Length – Each message has a maximum sign length allowed based on the size of the sign to be used.

- Beacon Indicator – Each stored message has a flag indicating whether beacons are set on/off.

Some messages may be designated as 'sign specific,' meaning that the message is only to be displayed on the indicated DMS. Displaying this message on any other sign will not make sense to travelers.

The algorithm to determine if the message will fit on a sign should be run when storing a message If the message will not fit on a certain sign, the system should alert the administrator so another message can be stored for the smaller signs.

At some point, the system will be required to take advantage of all functionality of the signs, including graphics. The system should be designed with this expansion in mind.

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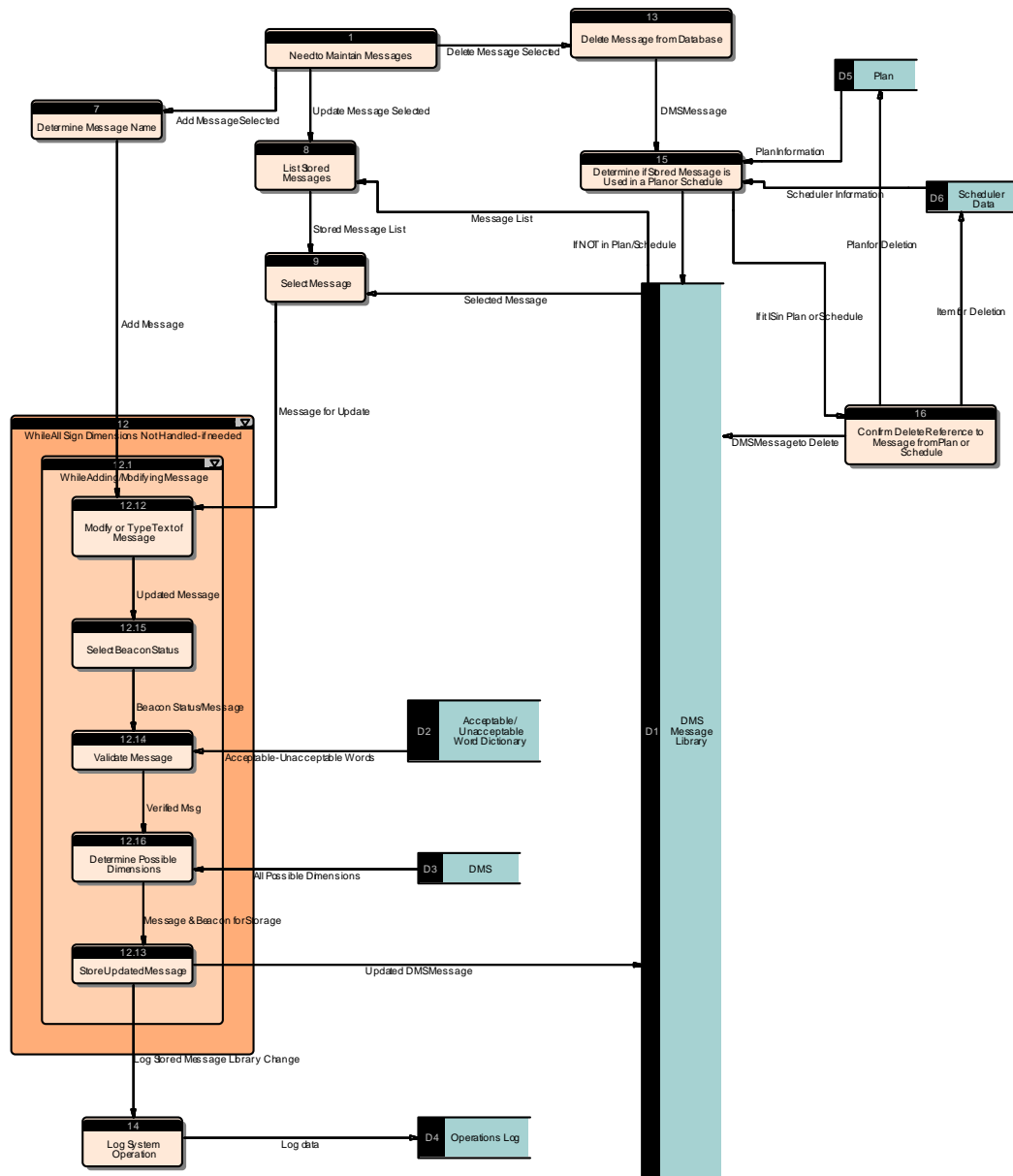
Figure 2-65. Maintain DMS Message Library

2.2.4.4.2.2 DMS – Add a Message

The DMS – Add a Message process provides the capabilities for operators to select one or more DMS devices, select or enter a message to be displayed, and add the message to the DMS message arbitration queues of the selected devices. Beacon status is related to a message and is also reflected in the queues. The associated log is updated to record the addition of a message to a device message queue. After adding a message to the queue, message arbitration is performed to determine if the change has affected which message(s) should be displayed on the sign.

The following comments were recorded in the process design workshops:

1. Error checking regarding what is on the sign versus what the system last sent to the sign should be done at a very low level. If polling results are only returned to the Chart II system on an exception basis from the FMS system, FMS may provide the error checking capability.

2. At some point, the system will be required to take advantage of all functionality of the signs, including graphics and complete diagnostics. The system should be designed with expansion in mind.

3. The system must be able to allow selected users to override/ignore the Acceptable Word Dictionary.

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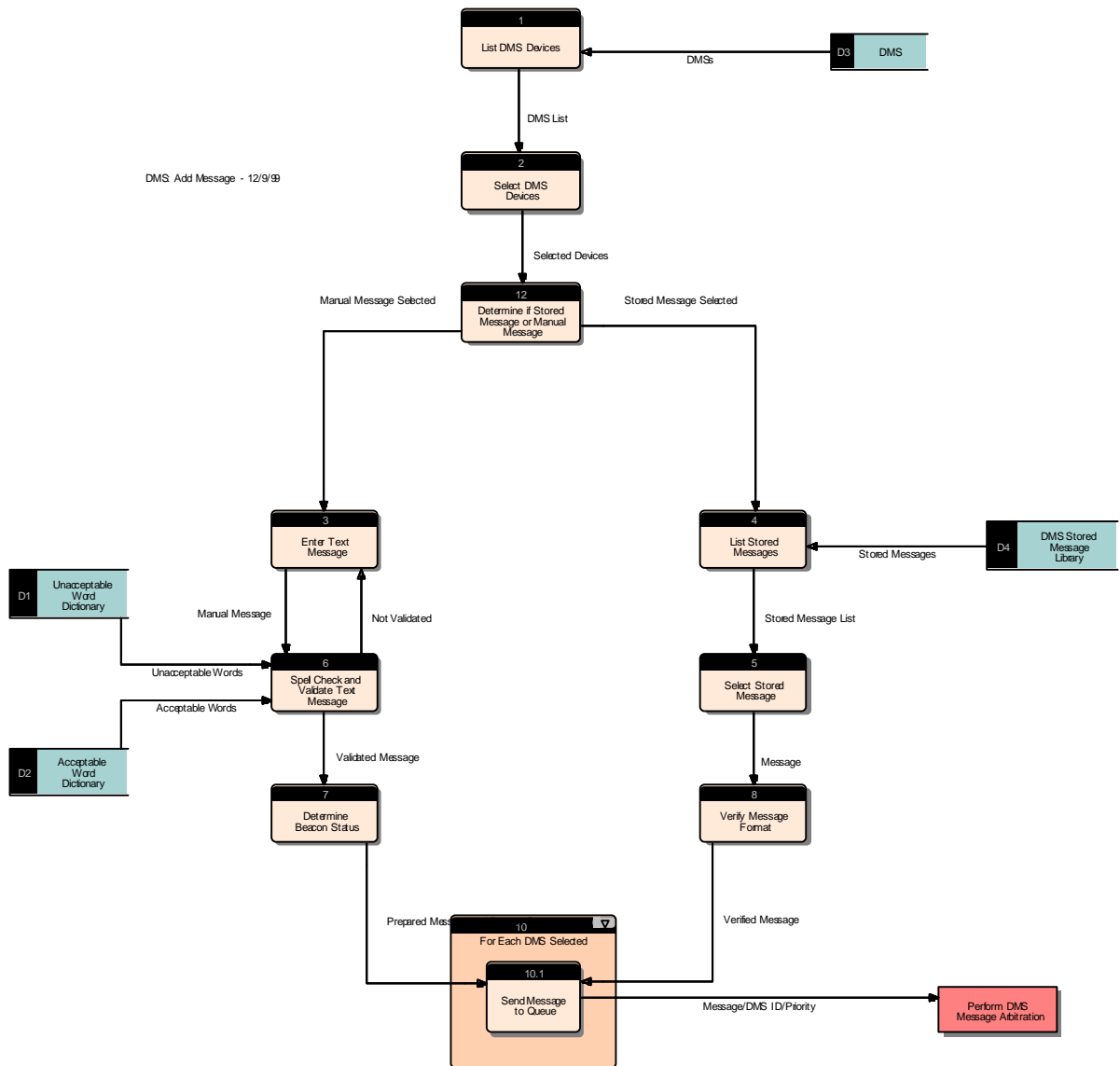
Figure 2-66. DMS – Add a Message

2.2.4.4.2.3 DMS – Remove a Message

The DMS – Remove a Message process provides the capabilities for operators to select a DMS devices (as related to a log or from a list of all devices), display the DMS message arbitration queue for the selected device, and remove a message from that queue. The log associated with the removed message is updated to record the removal of the message. After removal of a message from the queue, message arbitration is performed to determine if the change has affected which message(s) should be displayed on the sign.

DMS - Remove a Message - 12/9/99
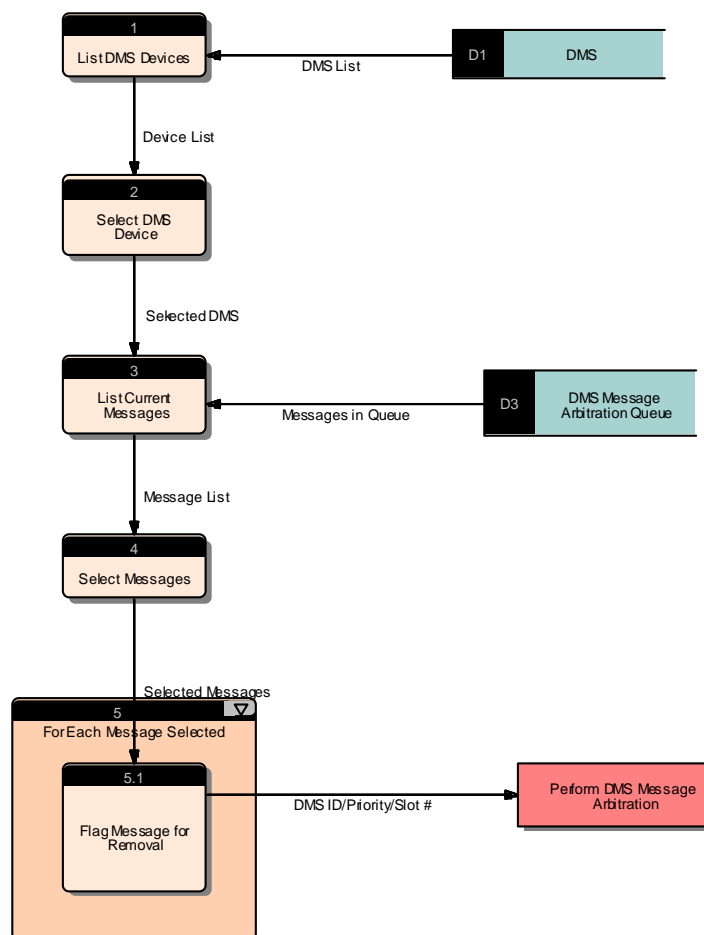
Figure 2-67. DMS – Remove a Message

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2.2.4.4.2.4 DMS – Arbitrate Message Queue

The DMS – Arbitrate Message Queue process maintains a message priority queue for each DMS device. When messages are added to the queue, this process adds or updates the correct priority level with the message information. Once the queue has been manipulated it is evaluated.

Each message in the queue is related to a specific log. Any one log will have only one message in a device queue at any one time.

The operator can remove messages from the queue manually or the system will remove all messages associated with a log when the log closes. The log is updated whenever an item is added or removed from the queue.

A scheduled message is placed in the appropriate priority level in the queue upon scheduler event-activation and removed upon scheduler event end-time.

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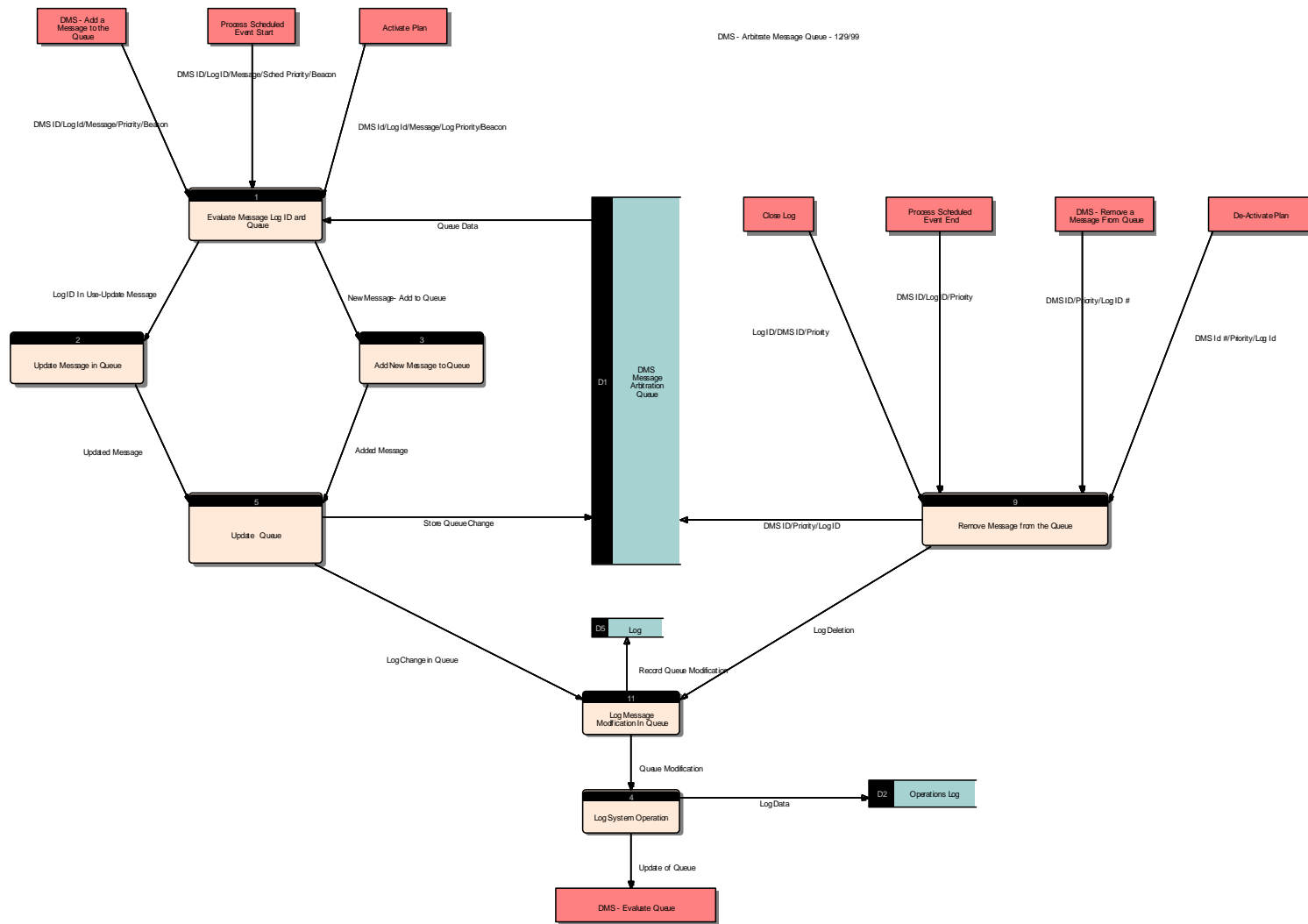
Figure 2-68. DMS – Arbitrate Message Queue

2.2.4.4.2.5 DMS – Evaluate Queue

The DMS – Evaluate Queue process determines which message(s) should be displayed on the device. Each time the queue is manipulated, the messages are re-evaluated. If the result of the evaluation is different from what is currently displayed, the message(s) for display is marked as pending and it is sent to the device. If the queue is empty the sign is blanked. There may be multiple messages at each priority level related to different logs. The highest priority message(s) is always displayed.
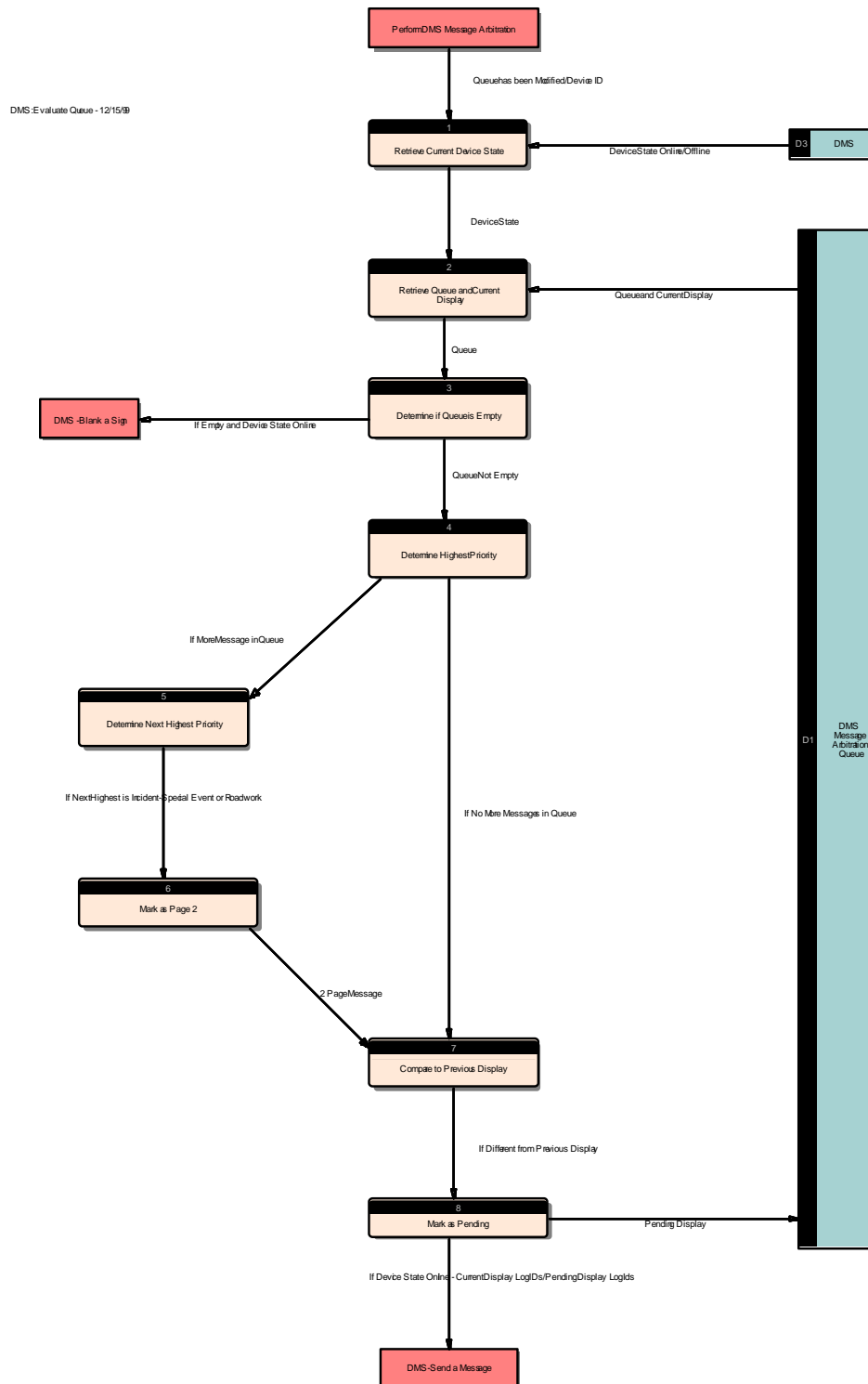
Figure 2-69. DMS – Evaluate Queue

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2.2.4.4.2.6 DMS – Send A Message

The DMS – Send a Message process provides the capability to initiate the interface with FMS to allow the message to be displayed on the selected device. Beacon status is related to a message. If the process indicates turning on or turning off the beacons when the selected message is displayed, this process also initiates the beacon controls through FMS to ensure the message is displayed before the beacons are turned on. Message arbitration is performed before any message is sent to the DMS. Once the message is displayed on the sign and the return status received from FMS that the command has been successful, the log associated with the message will be updated to reflect the new display status. The queue will be marked to show the message is currently displayed and no longer pending.
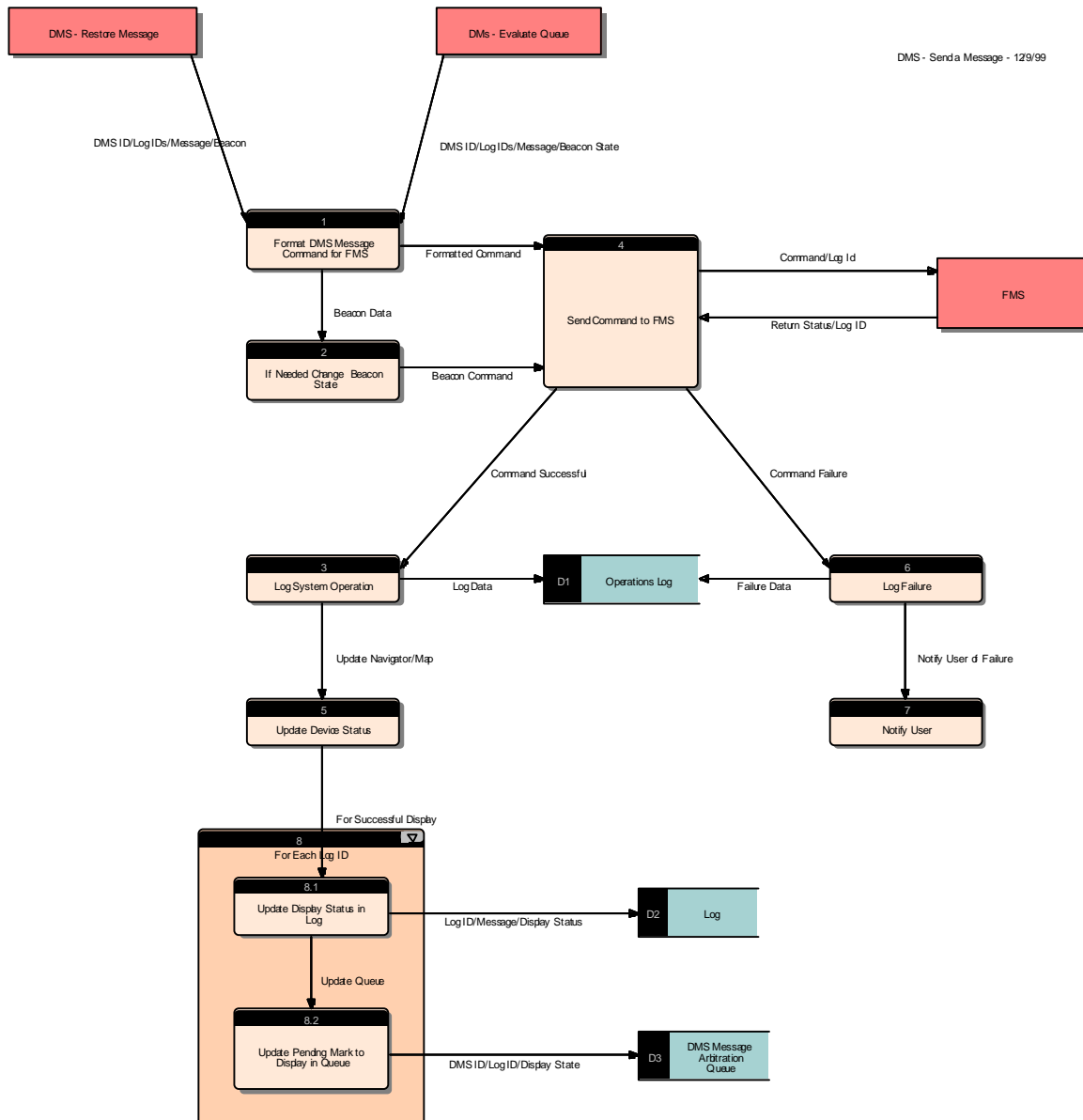
Figure 2-70. DMS – Send A Message

2.2.4.4.2.7 DMS – Blank A Sign

The DMS – Blank a Sign process provides the capability to initiate the interface with FMS to blank the selected device. If the beacon is currently on, this process initiates the beacon controls through FMS to ensure the beacons are turned off before the message is blanked. Once the message is blanked and the return status received from FMS indicates that the command has been successful, the operations log is updated to record a successful operation. Should the command fail, the fact is written to the failure log. The device status is updated as appropriate. (The log associated with the message is updated to reflect the actual time stamp of when the message was removed from the sign.)
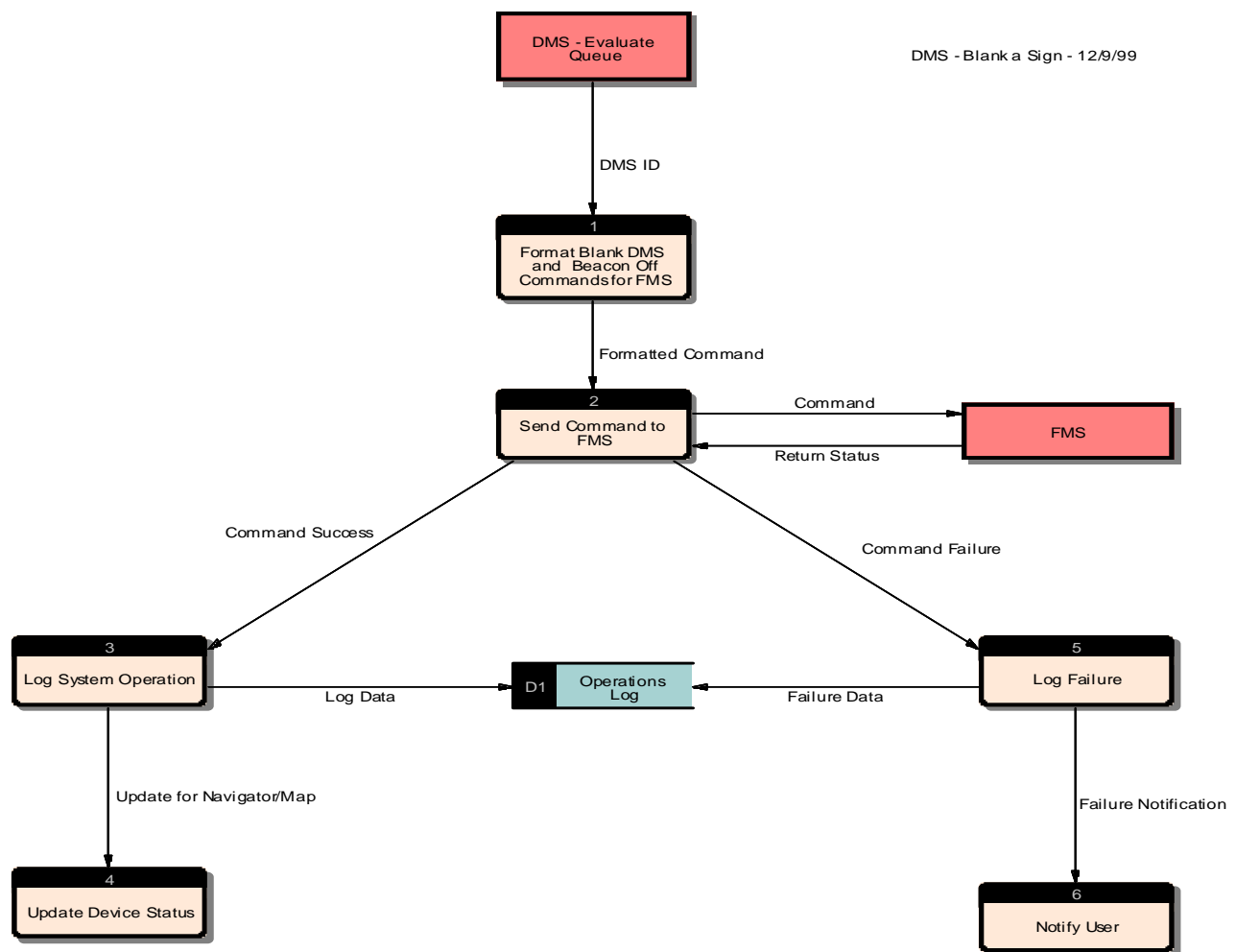
2.2.4.4.2.8 DMS Reset

The DMS Reset process allows an operator to force a reset of one or more DMS devices, which is sometimes necessary to overcome erratic device behavior. If the beacons are on, they are turned off before performing the reset. The log associated with the message(s) that is marked for current display in the DMS message arbitration queue is updated to reflect that it is not being displayed during the period required to perform the reset and restore the message. Upon

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completion of the reset, the system will determine the correct message to be displayed through message arbitration and initiate the display of the message on the sign.

It may be necessary to blank the sign prior to performing a reset to avoid confusing motorists. If the workings of a sign are such that it is left in a diagnostic mode upon completion of a reset, the sign should be blanked after reset. If either of these actions is appropriate for a given sign, it is expected that the blanking of the sign would be accomplished within the FMS application.

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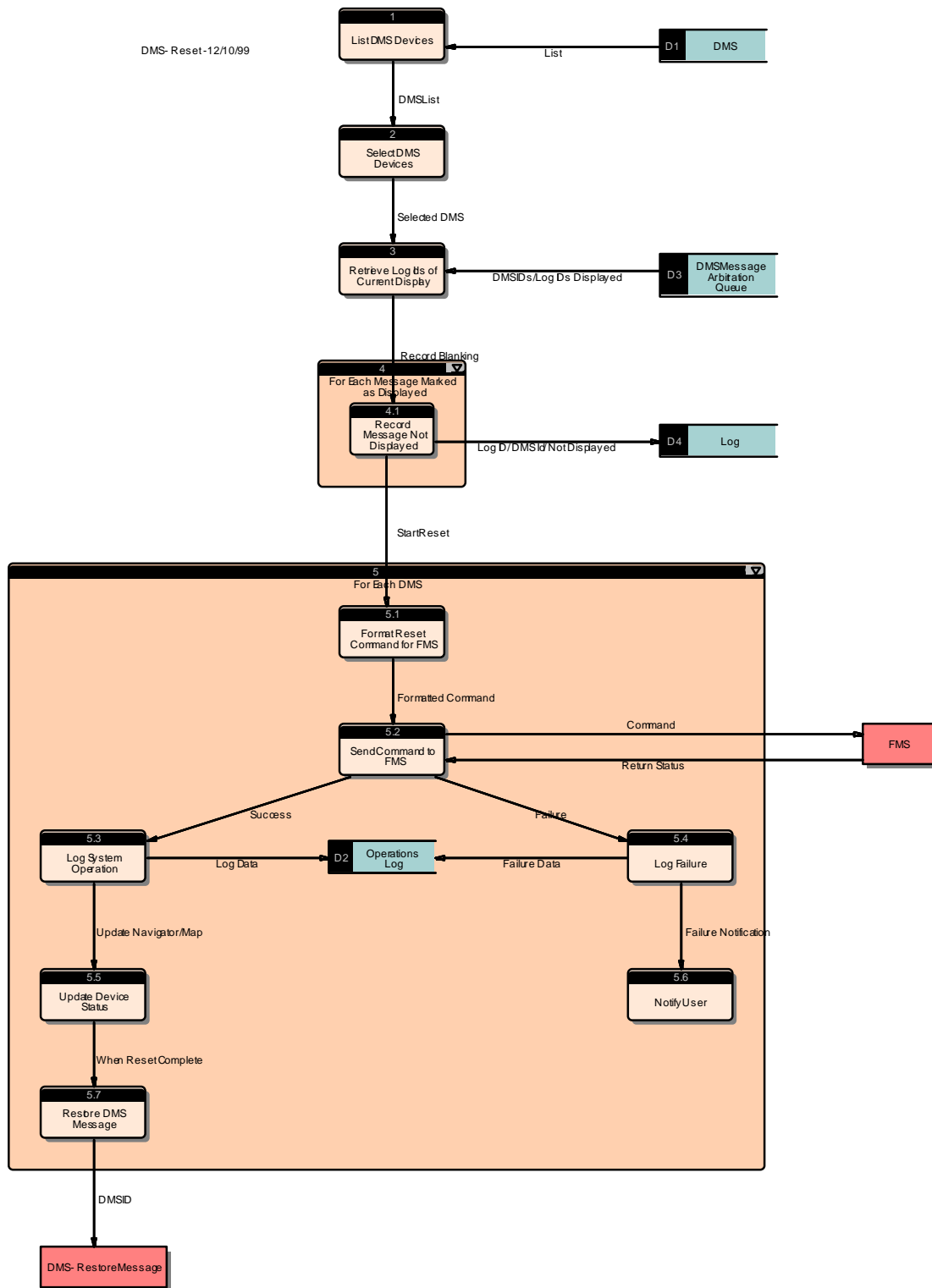
Figure 2-71. DMS - Reset

2.2.4.4.2.9 DMS – Restore Message

The DMS – Restore Message process determines which message(s) need to be displayed on a sign after a DMS – Reset. The DMS–Restore Message process determines which message(s) is marked for display and sends it to the device.
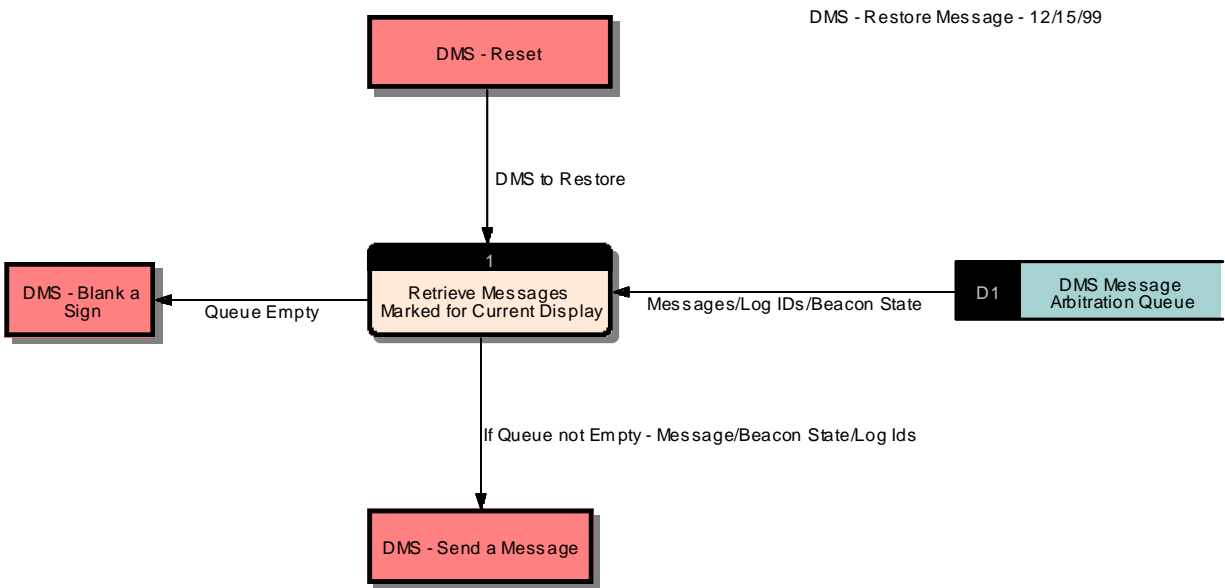
Figure 2-72. DMS – Restore Message

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2.2.4.4.2.10 DMS – Override Queue

The DMS – Override Queue process provides operators with the capability to adjust the priority settings of messages within a device arbitration queue in order to force a message to be displayed or not. The change to the priority will be in affect until the message is removed from the queue or again adjusted by an operator. The priority adjustment is recorded in the associated log.
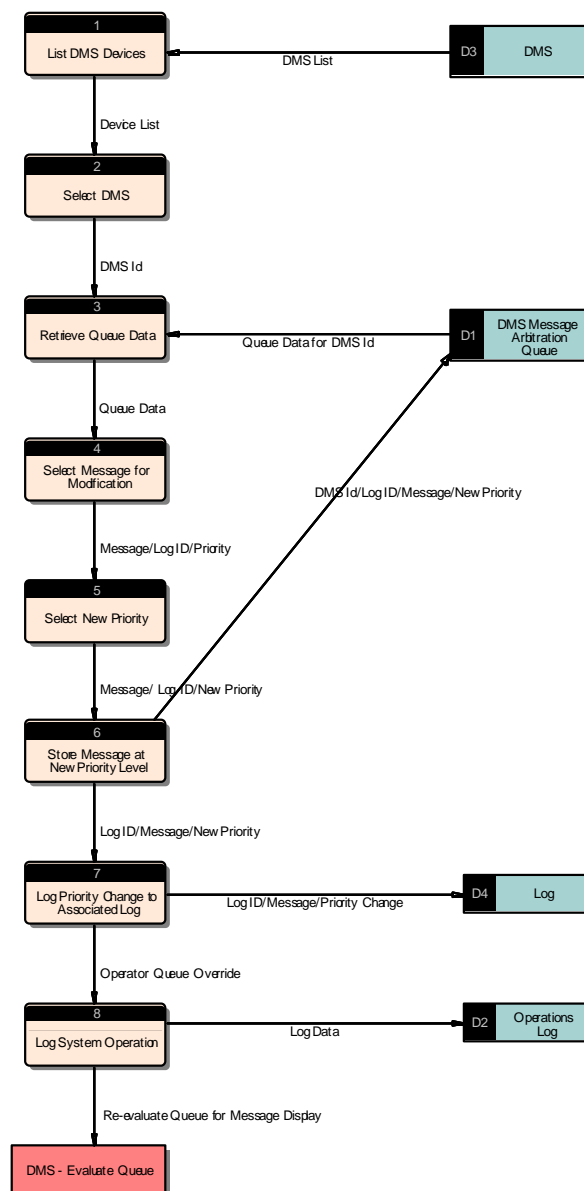
Figure 2-73. DMS – Override Queue

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2.2.4.4.3 HAR Processes

The HAR Processes group allows for the System Administrator to maintain the HAR Message Library and for CHART operators to select messages and devices for the broadcast and blanking of messages. Actual broadcasting of messages is handled through a message arbitration process that determines the priority of messages and directs qualified messages for broadcasting on the HAR devices.

2.2.4.4.3.1 Maintain HAR Message Library

The Maintain HAR Message Library process provides for the creation and maintenance of message text and voice files for pre-defined HAR messages.

Radio messages are comprised of three components:

1. Header – The header identifies the agency broadcasting the message. Although usually the SHA broadcasts the messages, it is sometimes necessary to identify a different agency (*i.e.,* the State Police)

2. Body – The body of the message contains the advisory information to be broadcast

3. Footer – The footer of the message is device specific since it contains the radio call letters and frequency of the specific HAR device.

The system is expected to be able to store and maintain HAR messages in both voice and text formats. The system should also provide the operator with the ability to enter both voice and text, or to allow entry of text and translate that text into voice (given a solution with an adequate voice quality – *yet to be determined*).

HAR controllers can store messages in designated slots with a total combined message time (including header and footer) of 6 minutes stored at the controller. Interface to the controller provides capabilities to recall and save messages. When no advisory message is active and the HAR is to be blanked, the default message in slot 2 is designated to be played. Active advisory messages are stored in slot 7. When sending messages to the controller, it is necessary to validate that the message was successfully updated.
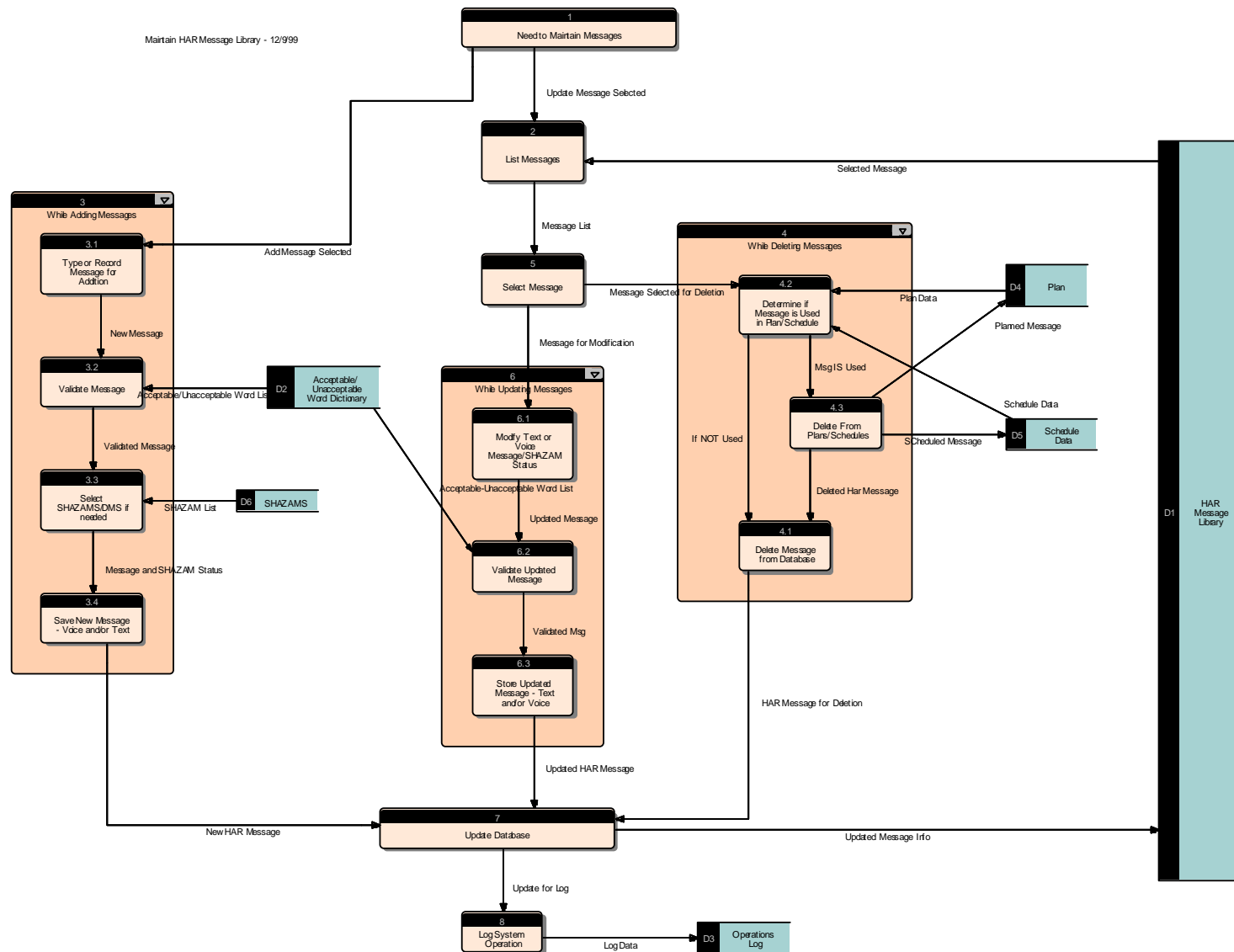
Figure 2-74. Maintain HAR Message Library

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2.2.4.4.3.2 HAR – Add A Message

The HAR – Add a Message process provides the capabilities for operators to select one or more HAR devices and select or enter an audio or text message to be added to the HAR message arbitration queue. Any message that exists as a stored message in text format or is typed by the operator may be translated by software to an audio file if a COTS package of sufficient quality is available. SHAZAM status is also selected. After addition of a message to the queue, message arbitration is performed to determine if the change has effected which message(s) should be broadcast. The related log is updated to record the action taken.
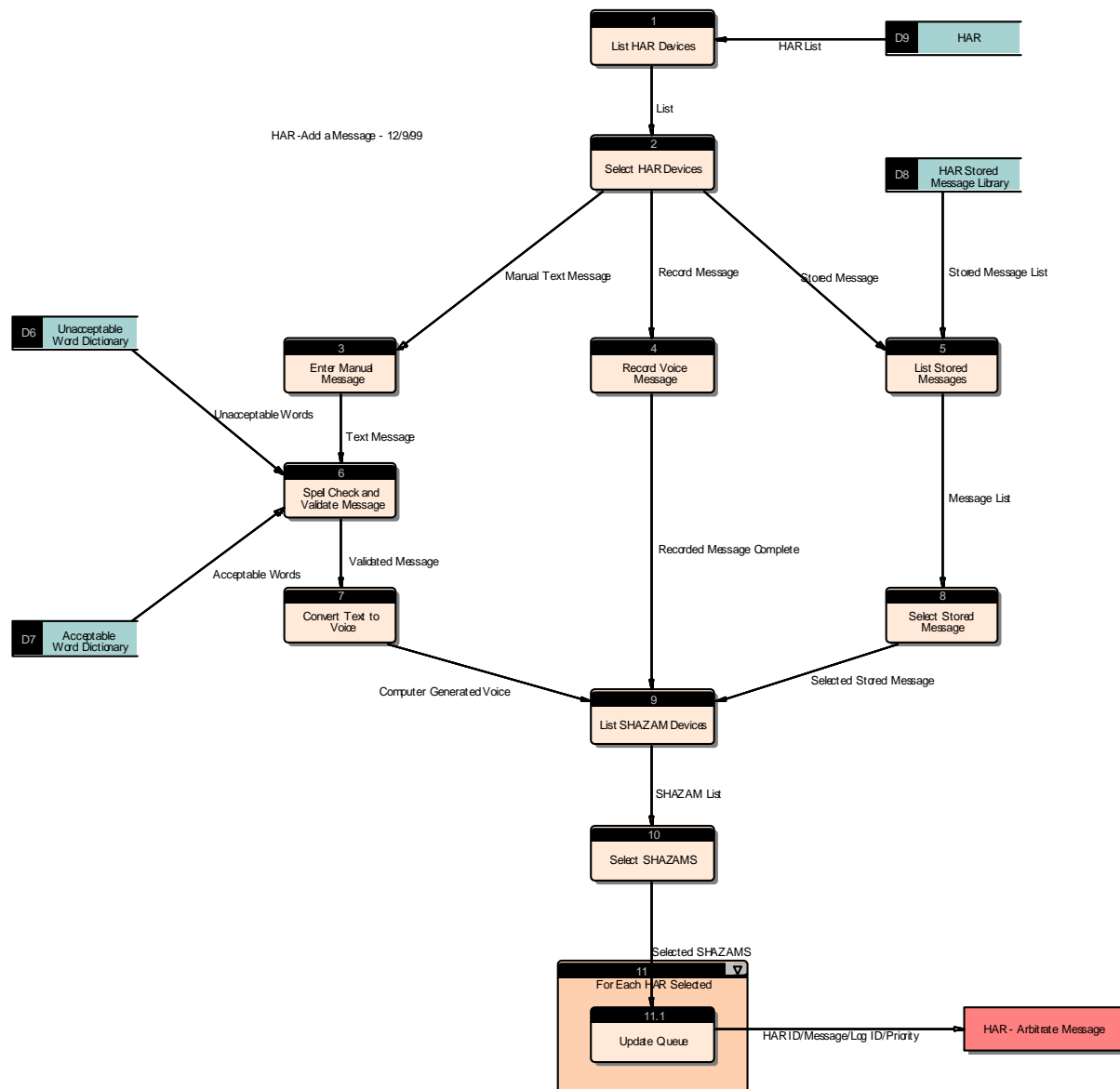
Figure 2-75. HAR – Add A Message

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2.2.4.4.3.3 HAR – Remove A Message

The HAR – Remove a Message process provides the capabilities for operators to select one or more HAR devices, display the HAR message arbitration queue for the selected device, and remove a message from that queue. After removal of a message from the queue, message arbitration is performed to determine if the change has effected which message(s) should be broadcast. The related log is updated to record the action taken.
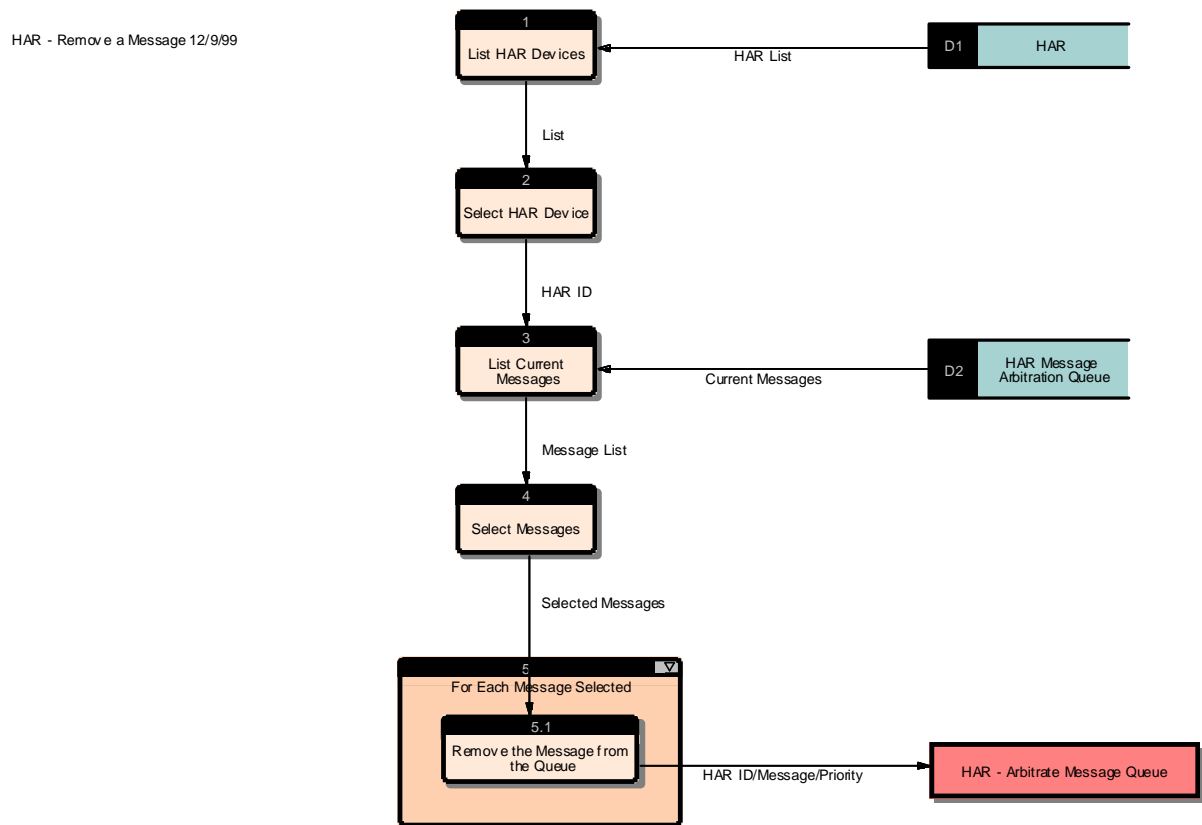
Figure 2-76. HAR – Remove A Message

2.2.4.4.3.4   HAR – Arbitrate Message Queue

The HAR – Arbitrate Message Queue process maintains a message priority queue for each HAR device configured in the system. When messages are added to the queue, this process adds or updates the correct priority level with the message information. Once the queue has been manipulated it is evaluated.

Each message in the queue is related to a specific log. Any one log will have only one message in a device queue at any one time.

The operator can remove messages from the queue manually or the system will remove all messages associated with a log when the log closes. The log is updated whenever an item is added or removed from the queue.

A scheduled message is placed in the appropriate priority level in the queue upon scheduler event-activation and removed upon scheduler event end-time.

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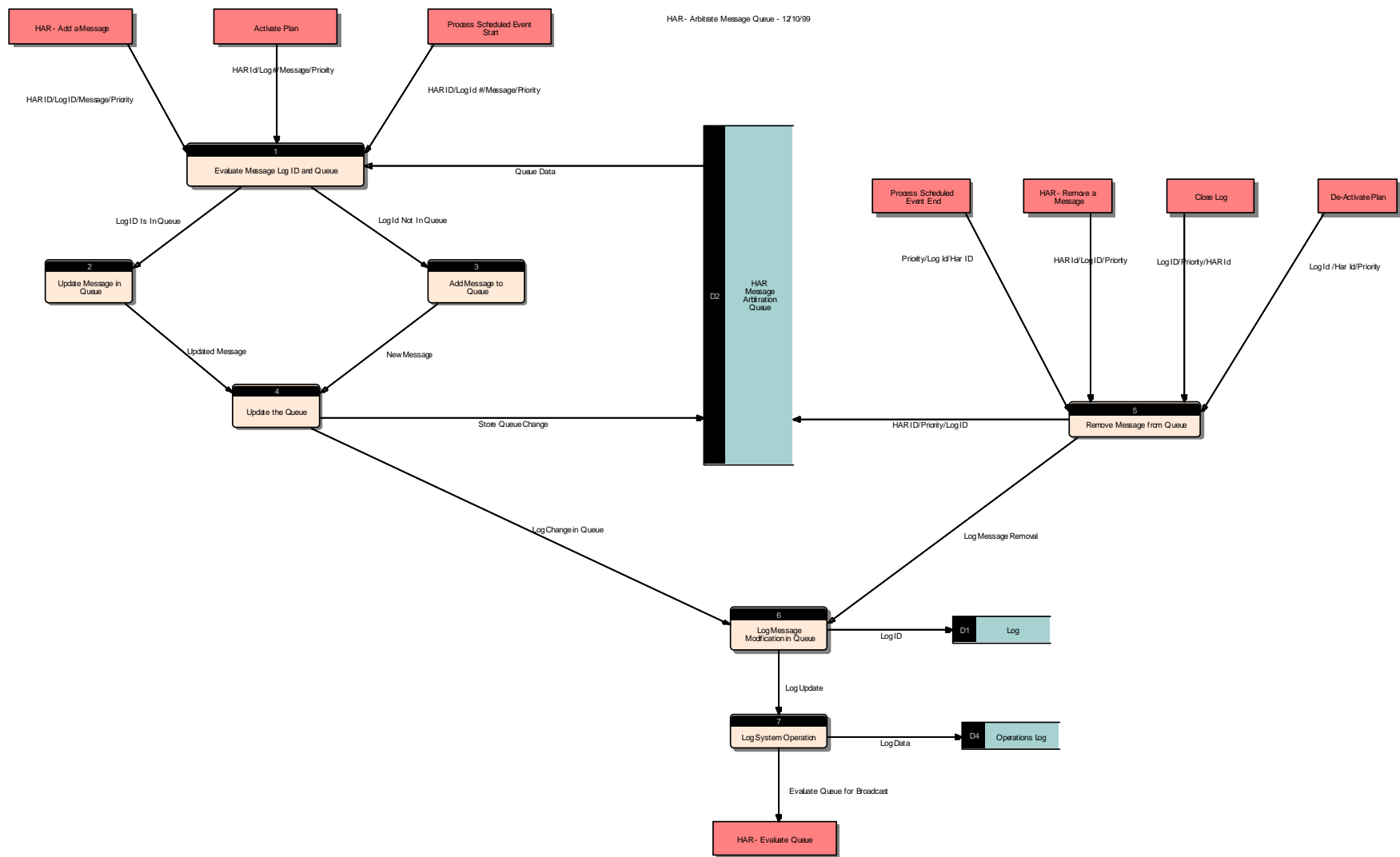
Figure 2-77. HAR – Arbitrate Message Queue

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2.2.4.4.3.5 HAR – Evaluate Queue

The HAR – Evaluate Queue process determines which message(s) should be broadcast on the device. The header, footer, and their broadcast time are determined. Starting at the highest priority, the messages are concatenated until all the messages are included for broadcast or another message would put the broadcast time over the maximum broadcast time. All messages used in the broadcast are marked in the HAR message arbitration queue as pending and the message is sent to the device. Each time the queue is manipulated, the messages are re-evaluated. If the result of the evaluation is different than what is currently displayed, the message(s) for broadcast is marked as pending and it is sent to the device. If the queue is empty the default message is broadcast. There may be multiple messages at each priority level related to different logs. The highest priority message(s) is always broadcast.
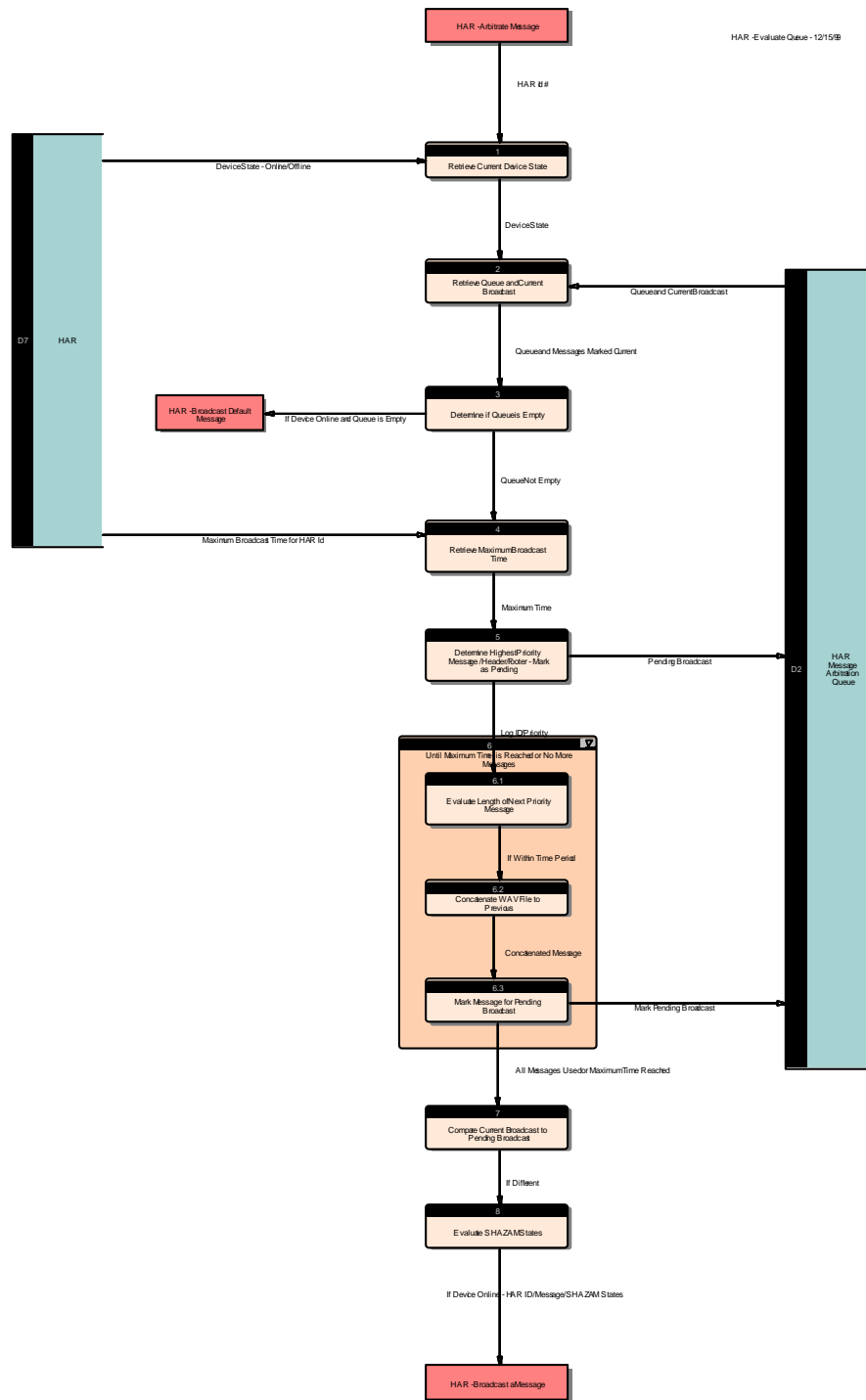
Figure 2-78. HAR – Evaluate Queue

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2.2.4.4.3.6 HAR – Broadcast A Message

The HAR – Broadcast a Message process provides the capability to initiate the interface with FMS to allow the message to be broadcast on the selected device. SHAZAM devices may also be initiated. Message arbitration and queue evaluation is performed before any message is sent to the HAR. Once the message is broadcast and the return status received from FMS that the command has been successful, the log associated with each broadcast message will be updated to reflect the new broadcast status. The queue will be marked to show the message is currently broadcast and no longer pending.

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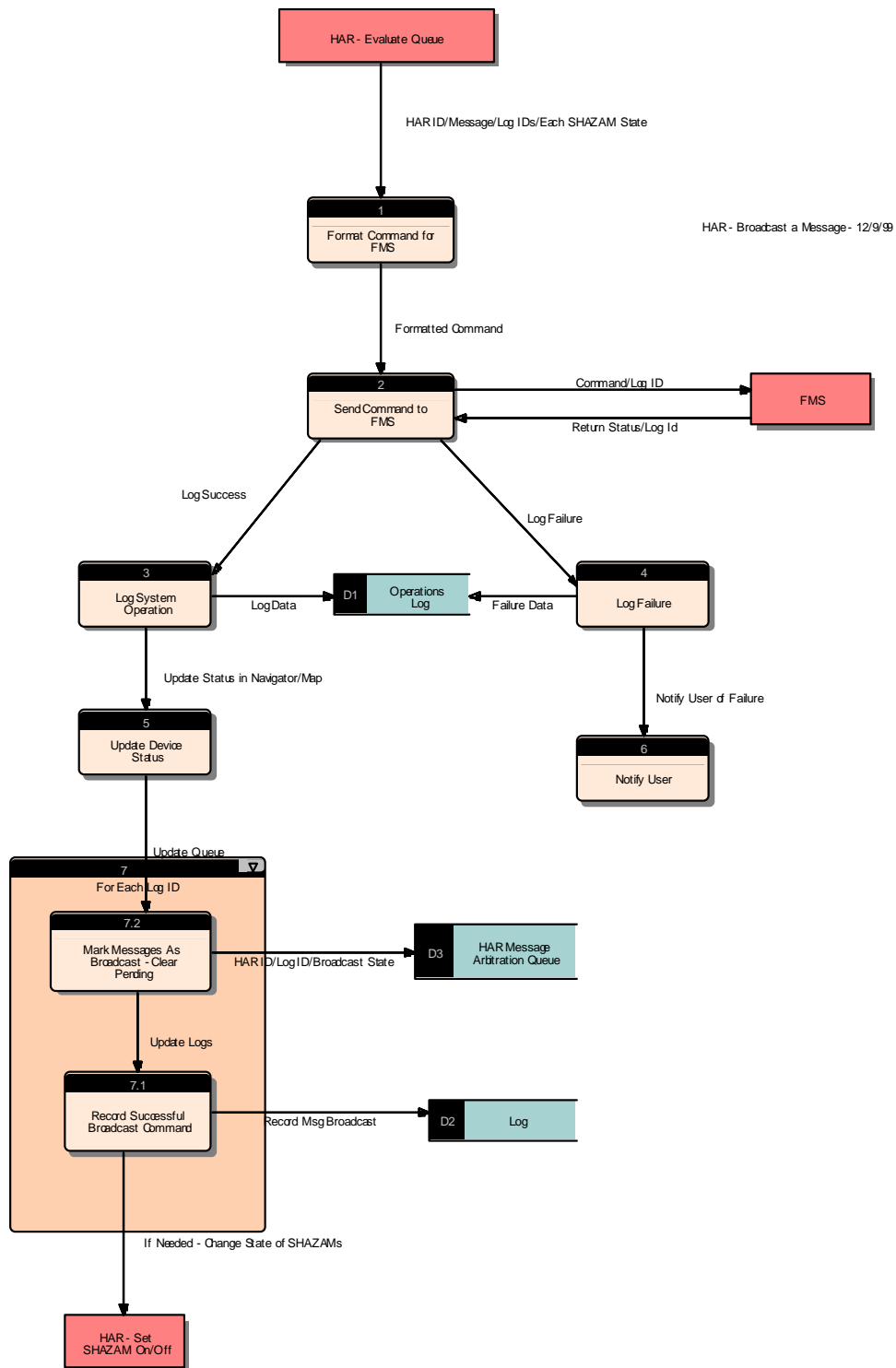
Figure 2-79. HAR – Broadcast A Message

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2.2.4.4.3.7 HAR – Broadcast Default Message

The HAR – Broadcast Default Message process provides the capabilities to begin broadcasting the default message for any HAR device when that device's arbitration queue no longer contains any priority messages. When evaluation of the HAR message arbitration queue determines that the queue is empty, any SHAZAMs that are set on are turned off. Once FMS returns a successful status and the devices are off, a command is sent for the HAR device to broadcast from the default slot.
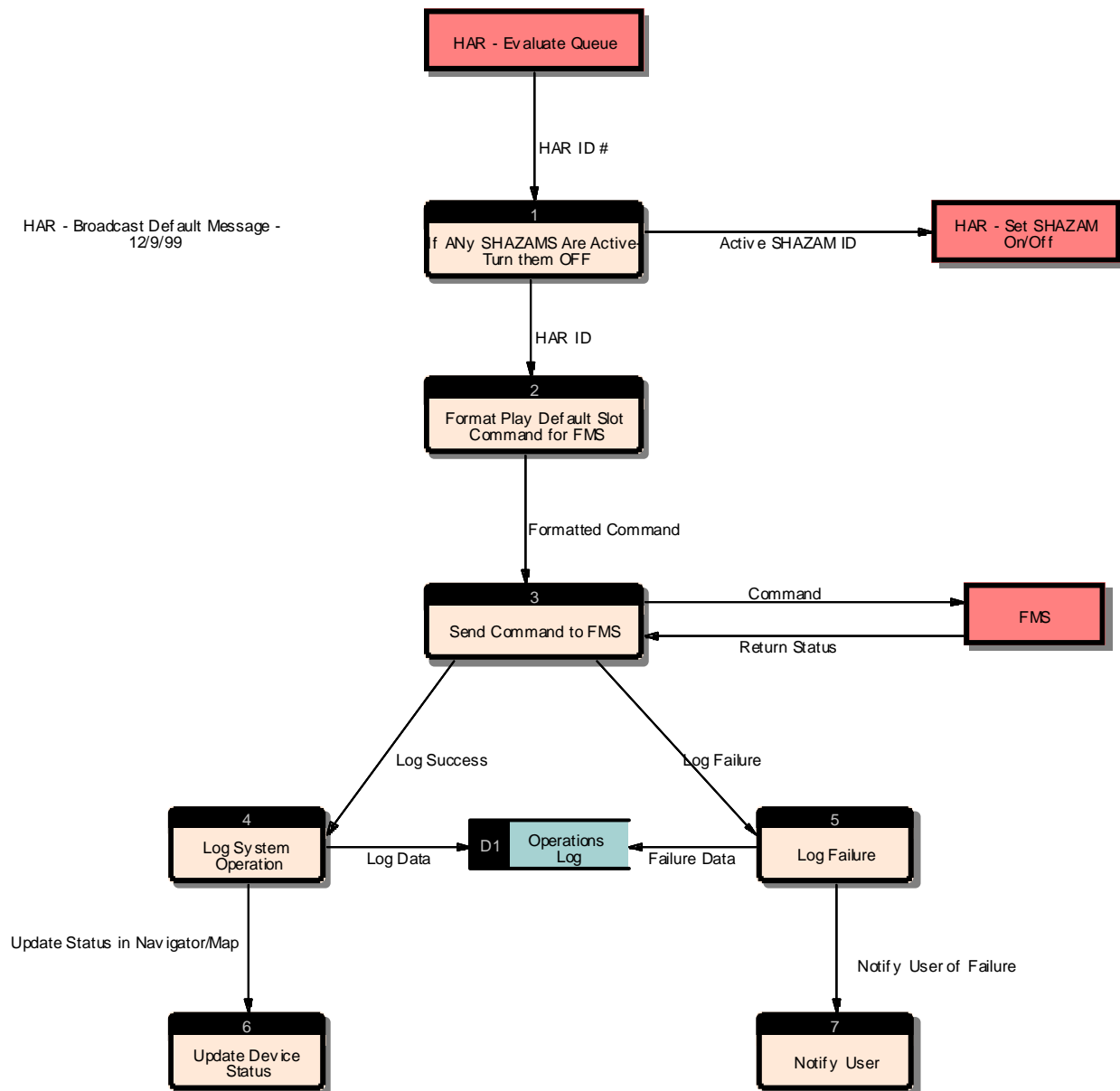
Figure 2-80. HAR – Broadcast Default Message

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2.2.4.4.3.8   HAR – Set SHAZAM On/Off

The HAR – Set SHAZAM On/Off process provides a means for the system to turn SHAZAMs on or off when broadcasting a message, or turn them off before broadcasting the default message. SHAZAMs are always turned on after the associated message reaches the HAR or turned off before it is sent to the HAR. DMS devices being utilized as SHAZAMs related to the specific HAR are also turned off by removing the SHAZAM message from the DMS arbitration queue and evaluating the queue for that DMS device.

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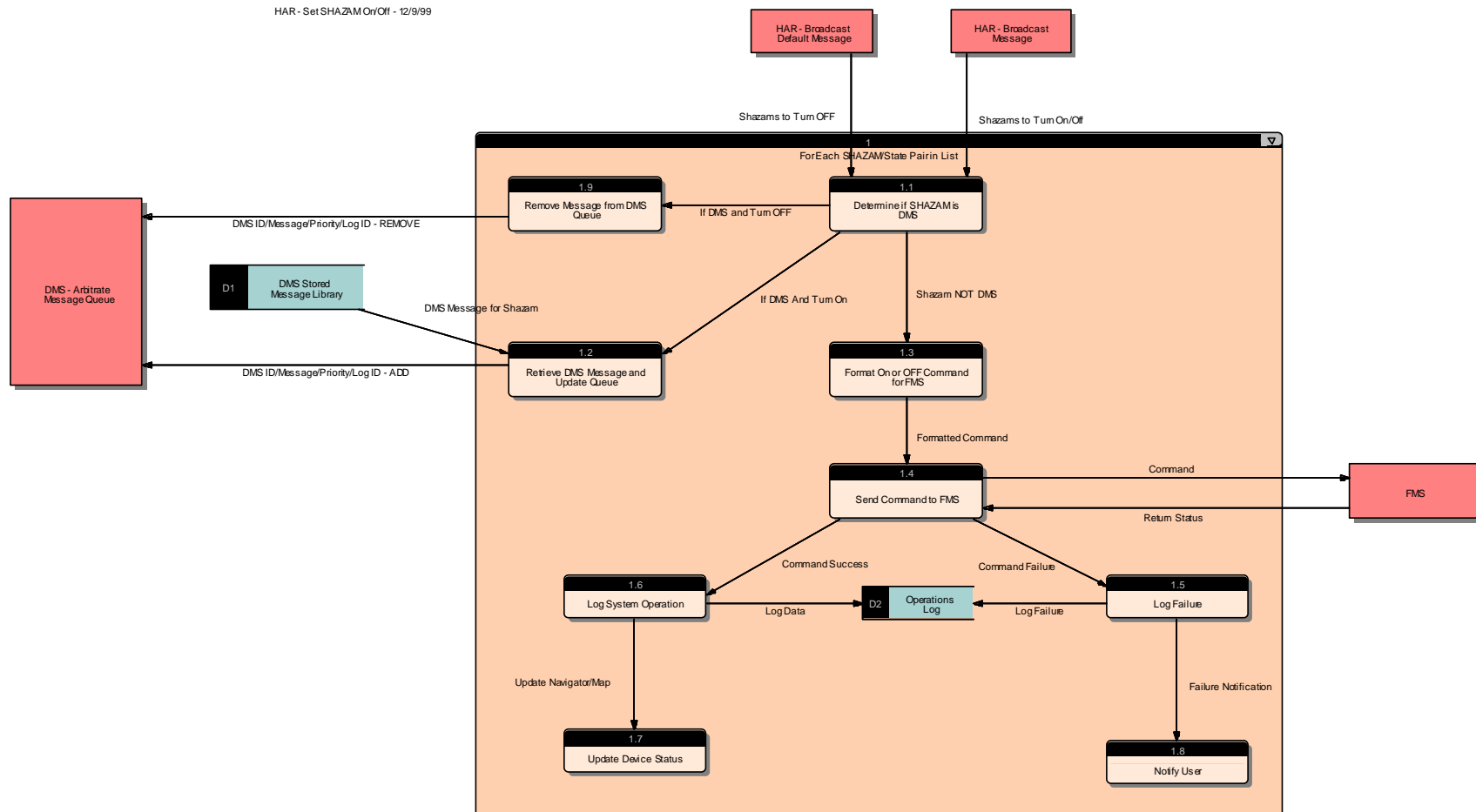
Figure 2-81. HAR – Set SHAZAM On/Off

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2.2.4.4.3.9 HAR – Update Default Message

The Update Default Message process allows the user to update the message stored in the default slot of the HAR controller. Whenever the HAR message arbitration queue is empty the default message is broadcast. The default HAR message is created by typing freeform text, recording a .WAV file, or selecting a stored library message. The message is then sent to FMS for storage in the default slot of the controller.
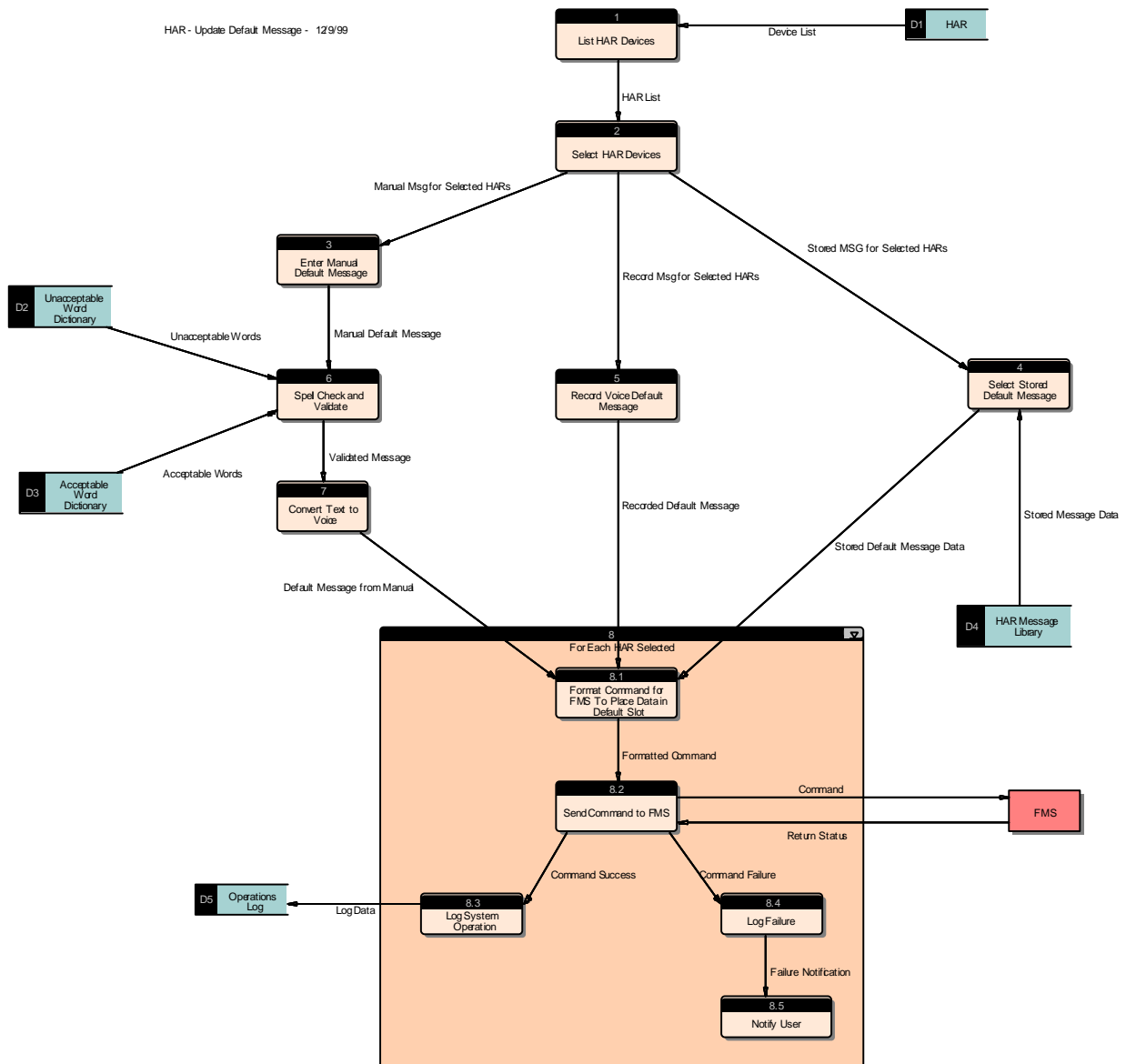
Figure 2-82. HAR – Update Default Message

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2.2.4.4.3.10 HAR – Send Maintenance Command

The HAR – Send Maintenance Command process allows the user to perform HAR controller functions including, but not limited to, setup, reset, and rebuild. The command is sent to the controller through FMS and, when a successful status is received from FMS, the message(s) marked for broadcast is sent to the controller. If the queue is empty, the default message is broadcast.

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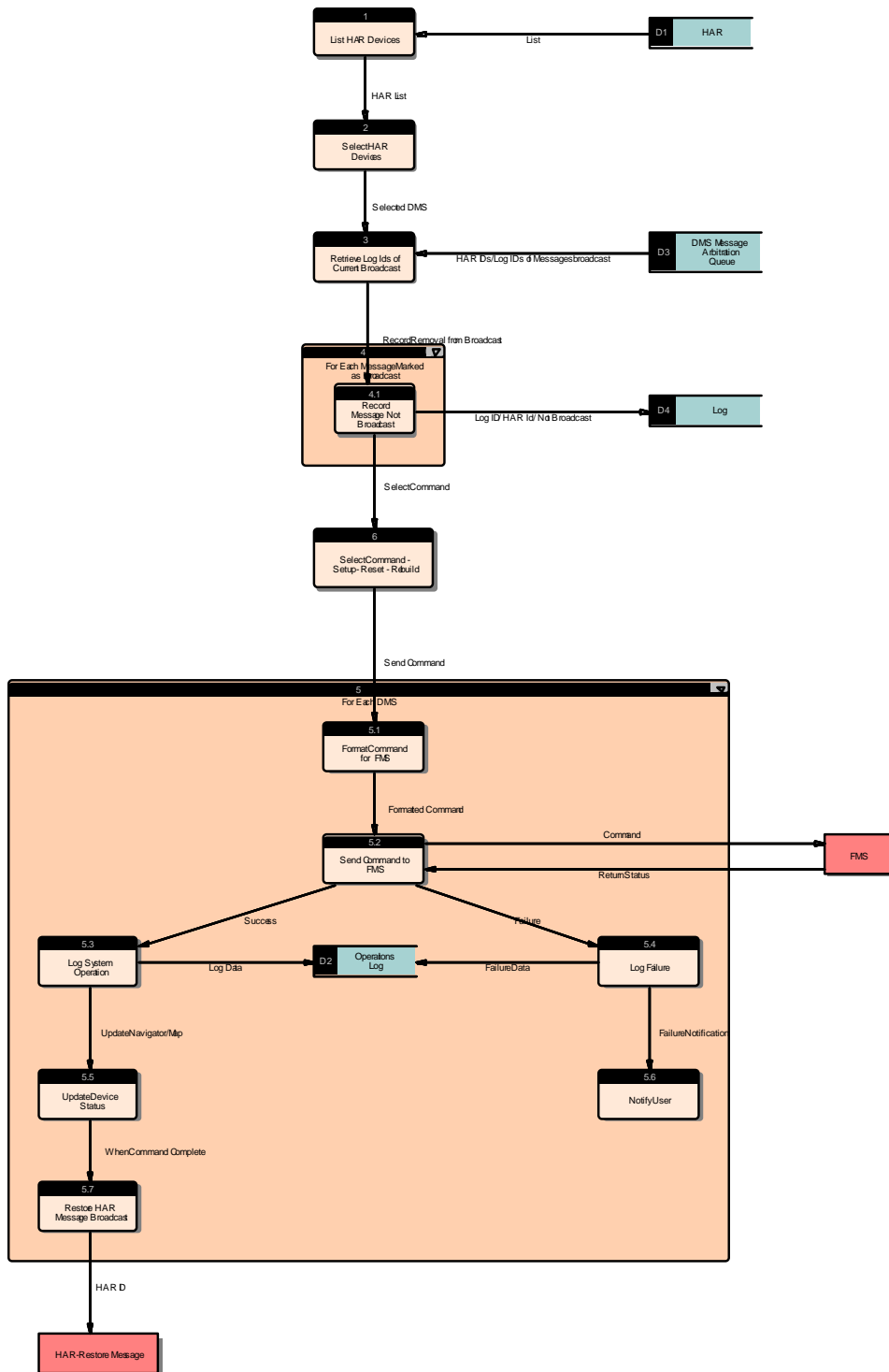
Figure 2-83. HAR – Send Maintenance Command

2.2.4.4.3.11 HAR - Restore Message

After a maintenance command has been sent to a HAR controller, the message(s) evaluated for broadcast must be restored to the device. The HAR – Restore Message process determines which message(s) is marked for broadcast and uses the HAR – Broadcast Message process to send it to the device. If the HAR message arbitration queue is empty, the command is sent to broadcast the default message.

HAR - Restore Message - 12/15/99
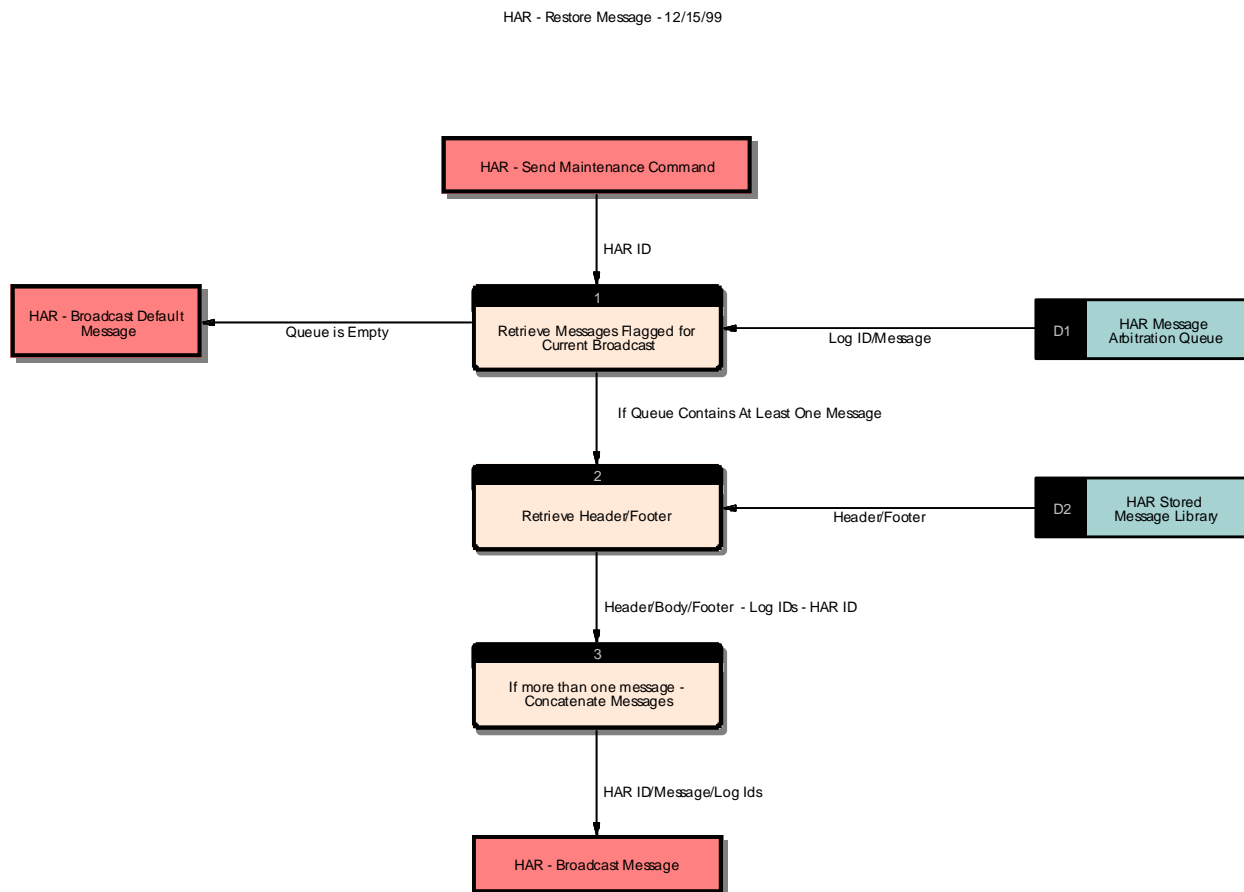
Figure 2-84. HAR - Restore Message

2.2.4.4.3.12 HAR – Override Queue

The HAR – Override Queue process provides operators with the capability to adjust the priority settings of messages within a device arbitration queue in order to force a message to be broadcast or not. The change to the priority will be in effect until the message is removed from the queue or again adjusted by an operator. The priority adjustment is recorded in the associated log.
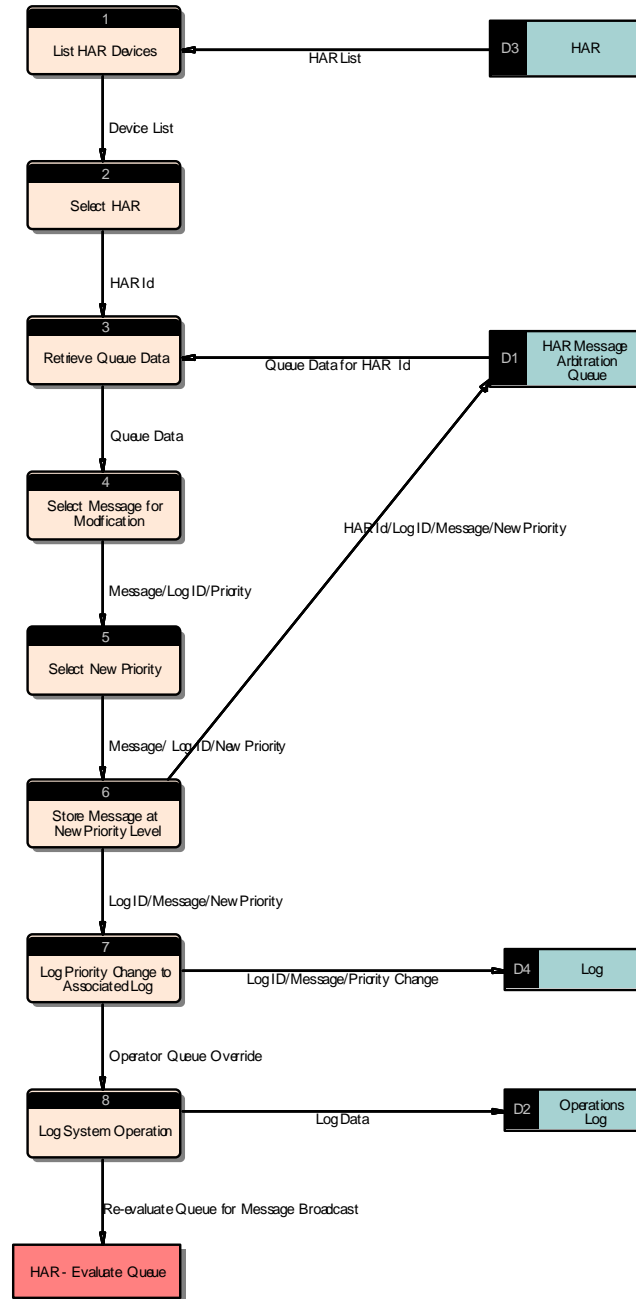
Figure 2-85. HAR – Override Queue

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2.2.4.4.4 AVCM

The AVCM Processes group allows for users with appropriate rights to maintain the Wall Monitor Configurations, CCTV Presets, and Tours. The CHART operators are able to Control Wall Monitor Assignments, Activate Tours, and Control Cameras.

2.2.4.4.4.1 Maintain Wall Monitor Configuration

The Maintain Wall Monitor Configuration process is a System Administration function, which is used to establish/define the monitors to be displayed on the walls at the centers, media video feed channels, VCR devices, and Web Page feeds. For actual wall mounted configurations, it is expected that a GUI interface will be provided to ease the operator's capabilities to assign a camera to a monitor or projector.

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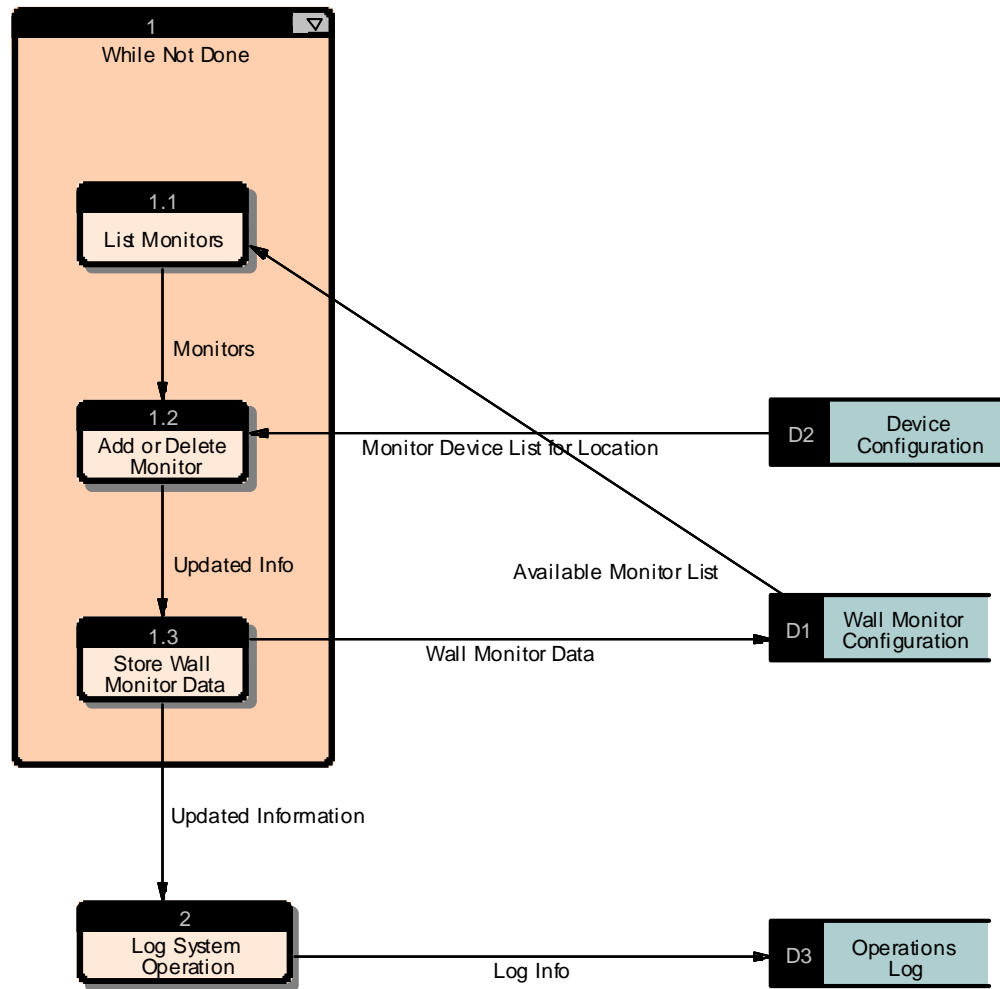
Figure 2-86. Maintain Wall Monitor Configuration

2.2.4.4.4.2 Control Wall Monitor Assignment

The Control Wall Monitor Assignment process is an operational function, which enables the CHART Operators at each center to direct output from a tour or a camera to a specific wall monitor or projector, media video feed channel, VCR device, and Web Page feed.

Contol Wall Monitor Assignment- 12/7/99
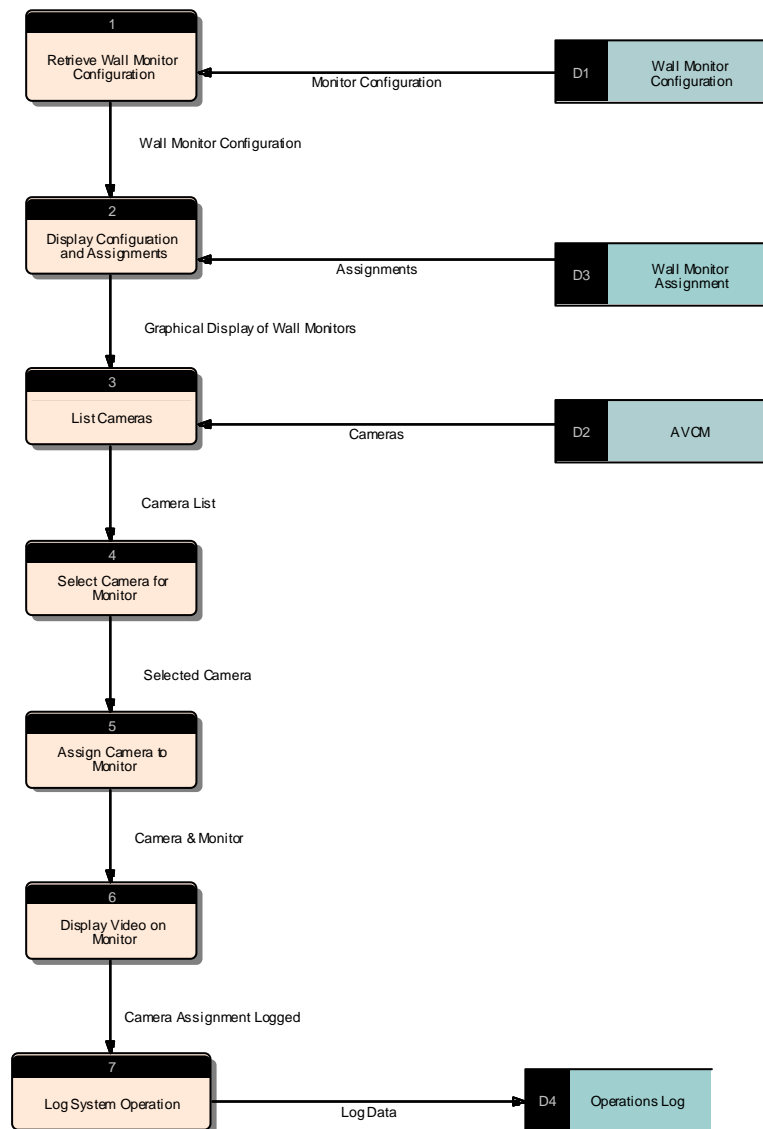
Figure 2-87. Control Wall Monitor Assignment

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2.2.4.4.4.3 Maintain CCTV Presets

The Maintain CCTV Presets process is a System Administration function used to maintain the stored presets for the AVCMs.
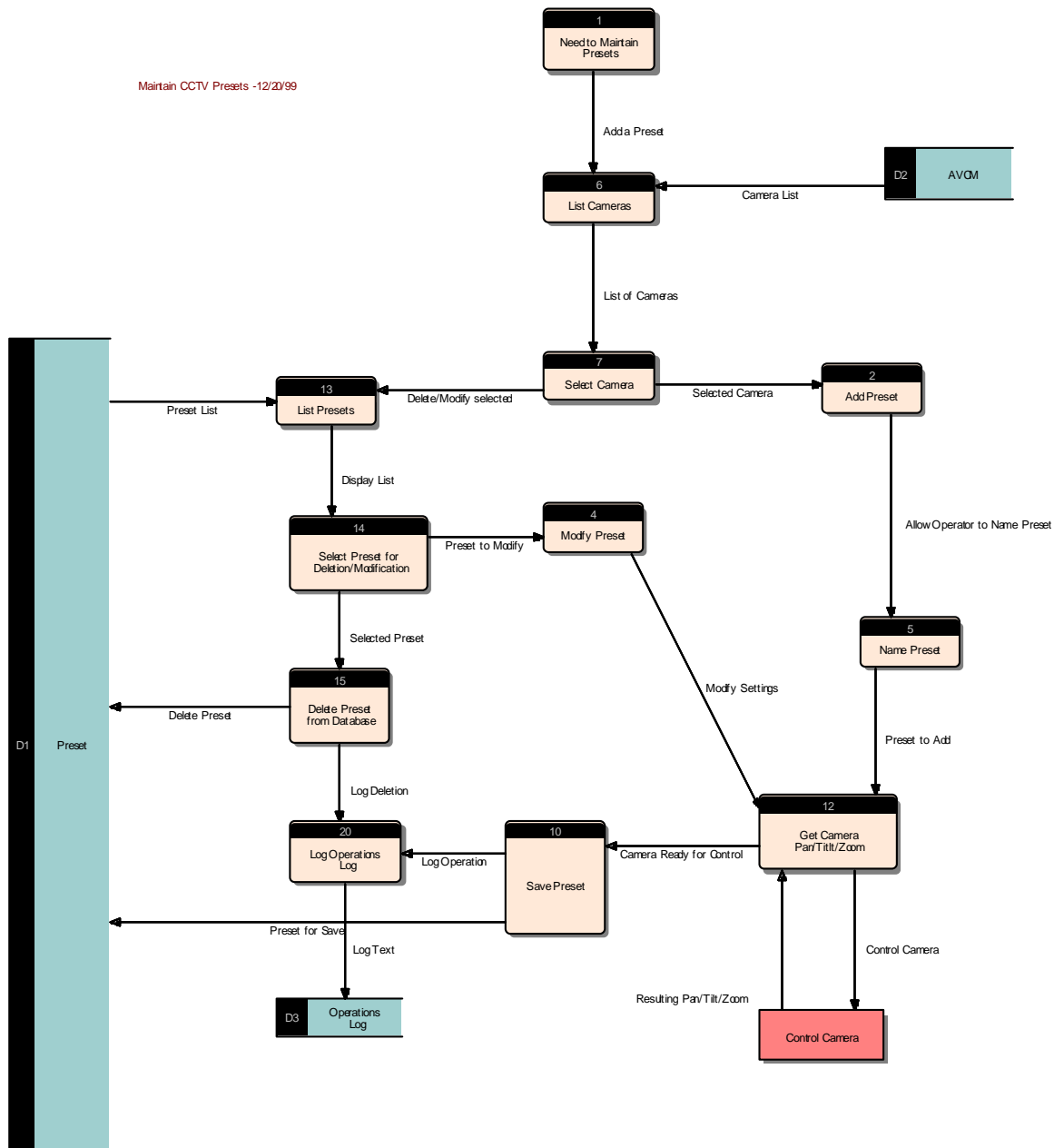
Figure 2-88. Maintain CCTV Presets

2.2.4.4.4.4 Refresh Default AVCM Presets

The Refresh Default AVCM Preset process is a custodial function, which is used to return a camera to its original default position at a scheduled time.

Refresh Default AVCM Presets - 9/17/99
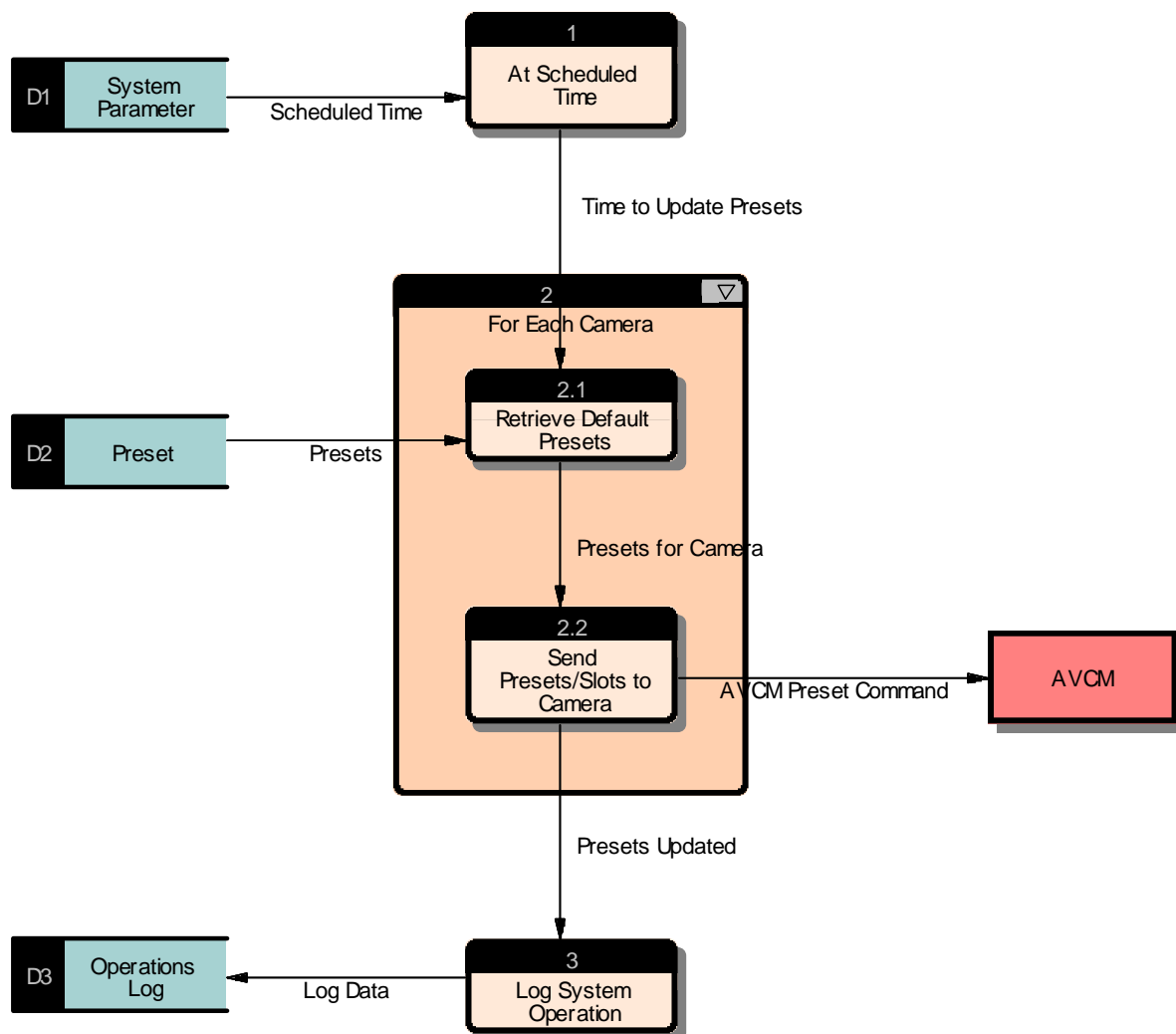
Figure 2-89. Refresh Default AVCM Presets

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2.2.4.4.4.5   Maintain Tours

The Maintain Tours process is used to change the configurations of cameras being displayed on a monitor. There could be different tours to maintain, whether they are for wall monitors or for web and media feeds. As part of the tours, the frequency and sequence of the specified cameras used for the tour is maintained. This process will be handled by the System Administrator.
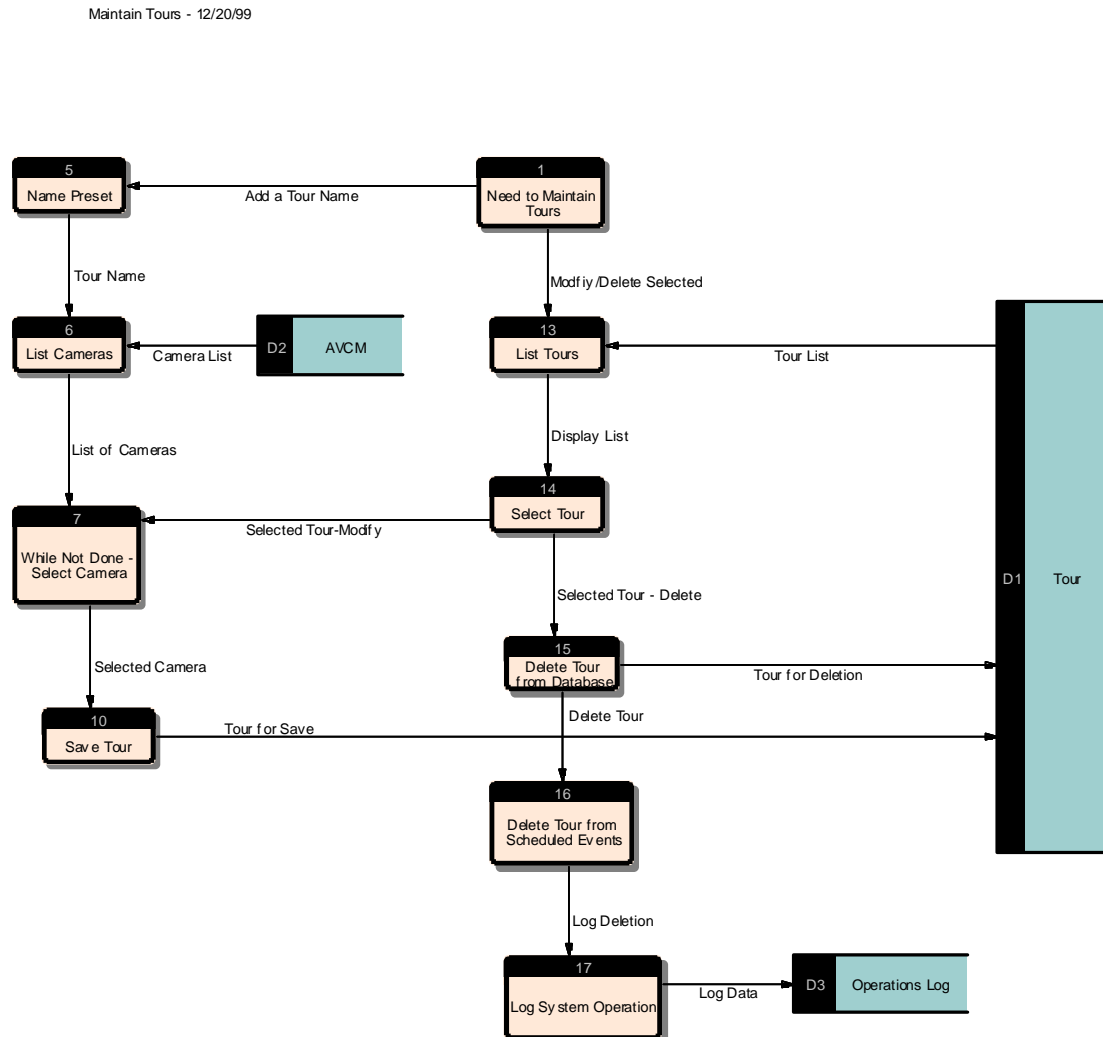
Figure 2-90. Maintain Tours

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2.2.4.4.4.6 Activate Tour

The Activate Tours process is used when a CHART Operator needs to activate a tour of cameras. This is an operational process.
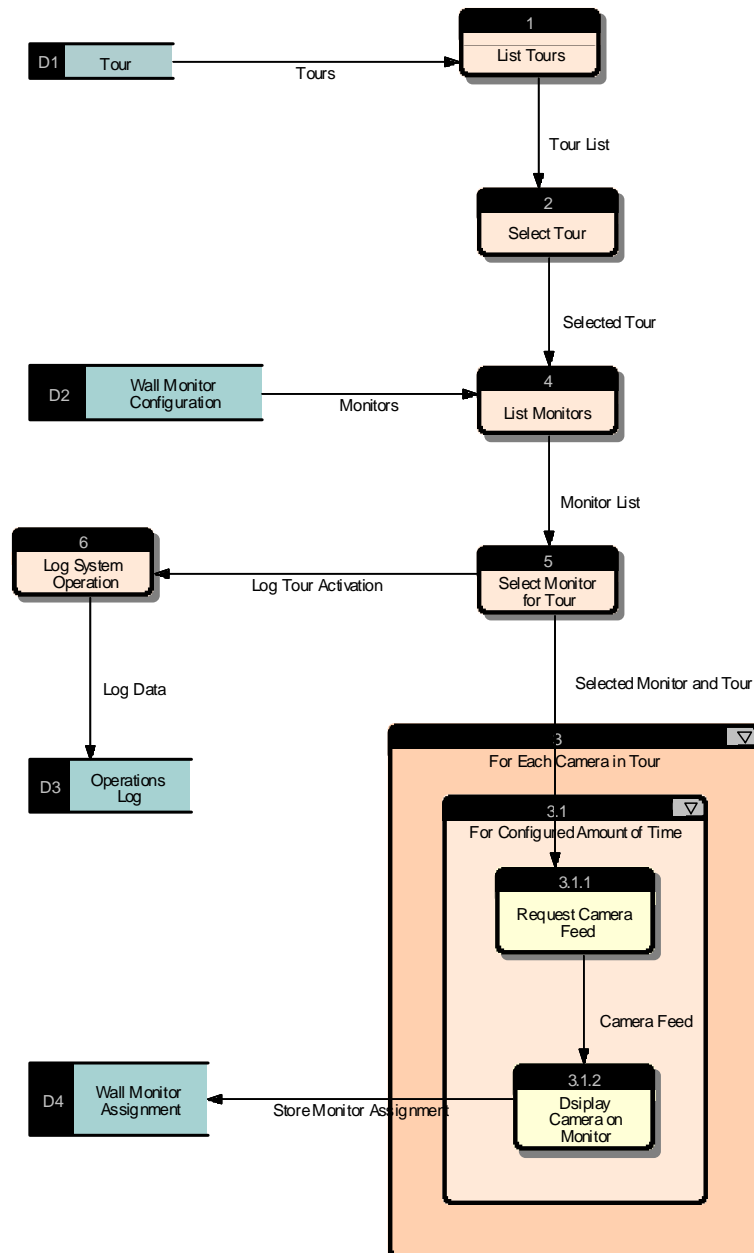
Figure 2-91. Activate Tour

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2.2.4.4.4.7 Control Camera

The Control Camera process is an operational function, which enables the CHART Operators to take control of a camera, as needed, as part of an incident verification. Use of a specific camera for incident verification should be noted in the Incident Log.

Figure 2-92. Control Camera

2.2.4.4.5 Detectors

The Detectors process group is comprised of Custodial processes which first receive information regarding traffic flow, generate system response plans based on the traffic flow data, then alert key personnel should information received point to a disruption in traffic flow.

2.2.4.4.5.1 Handle Polled Detector Data

The Handle Polled Detector Data process is used to receive data from FMS in order to analyze the flow of traffic, and to alert individuals if traffic flow falls below pre-determined parameters. As data is received from FMS, either smoothed data or a failure status is sent to the CHART system. If a failure is reported, the failure is logged in the failure log. If smoothed data is received, the information received will be used to calculate the new history. The smoothed data is then sent to the Handle Detector Rules process for evaluation against traffic flow thresholds.

This process will need to be closely reviewed during detailed design to verify the availability of the types of data from the detectors, as well as confirmation of the level of data stored in the operational and archive databases.

CHART II Business Area Architecture Report   179   August 23, 2000
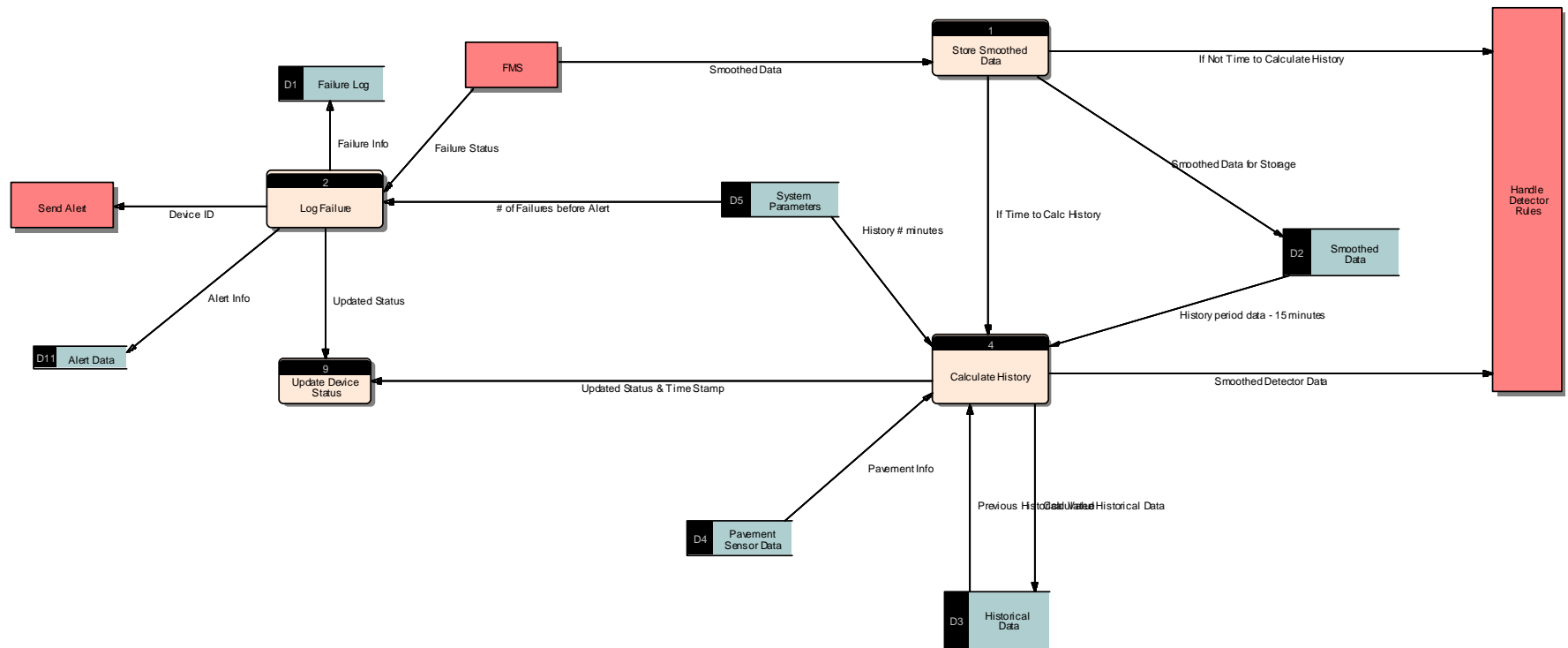
Figure 2-93. Handle Polled Detector Data

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2.2.4.4.5.2 Handle Detector Rules

The Handle Detector Rules process compares incoming smoothed detector data against thresholds stored as system parameters and historical data. Historical data is maintained based on type of day, day of week, time of day (15 minute increments), and type of weather. Current weather sensor data is used to define the set of historical data to be used for comparison.

The results of the evaluation may show normal flow, congested flow, or a potential incident. If the evaluation shows a normal flow, it is determined if there was a previous congested or incident state for this detector device. If the detector had been in a non-normal flow state, it is determined if the flow has returned to normal for a configured number of polling cycles and, if so, closes the associated congestion or incident log. The first polling cycle showing a normal state will not trigger the release of devices to prevent premature deactivation.

If the result of the evaluation shows congestion, the congestion response process is activated to generate a congestion log and determine the correct device response for traveler information.

If the result of the evaluation shows a potential incident, the incident response process is activated to generate an alert, incident log, and determine the correct response plan.

Handle Detector Rules -12/13/99

Hande Detector Data

Smoothed Detector Data

18
Check detector for current use in congestion/incident

20
Log Incident Detection to Open Incident Log

Incident Log Exists - Incident Detected - Update Log

Gererate Incident Response

Non - Normal Speed/ NO Incident Log Open

Log ID/Type if it exists

Gererate Congestion Response

Congestion Detected/No Activity Log Open

2
Compare Data to Historical

Congestion Log Exists - Congestion Detected - Update Log

19
Log Congestion Detection to Open Congestion Log

Update Incident Data

Historical Data

Update Congestiion Data

D6 Historical Data

D8 Congestion Log

D9 Incident Log

Thresholds

Pavement Sensor Data

Flow Normal and Greater Than 35 MPH

1
Has # Normal Responses Reached # Needed to De-Activate Inc-Cong Response

D10 Pavement Sensor Data

Congestion Log ID

Incident Log ID

D2 System Parameters

Normal Pdls Needed to De-Activate Inc/Cong Response

Reached

5
Determine Log Type & Retrieve Log Id

NOT Reached

Devices De-Activated

Log Id for Deactivation

6
Increment # Normal Responses

If change in threshold

11
Update Map

Log De-Activate

Close Log

Log Increment

D3 Operators Log

Log Data

17
Log System Operation

Figure 2-94. Handle Detector Rules

2.2.4.4.5.2.1 Generate Congestion Response

When the evaluation of incoming detector data in Handle Detector Rules shows congestion, and the previous reporting of the device did not show congestion, a congestion log is opened. The devices in a pre-determined radius from the detector are added to the system-generated response plan for display or broadcast of messages created from the congestion response rules. Any defined notification is added to the system-generated response plan. The system is configured to require operator confirmation or allow activation of the plan without operator confirmation. If confirmation is required, an alert is sent to the operator(s) at the center responsible for the detector that triggered this process. If confirmation is not required, the system generated response plan is activated. The system may be configured to alert the operator that a congestion response plan has gone into affect. The location of the congestion and all activated system responses are logged in the congestion log for later archive.

CHART II Business Area Architecture Report   183   August 23, 2000
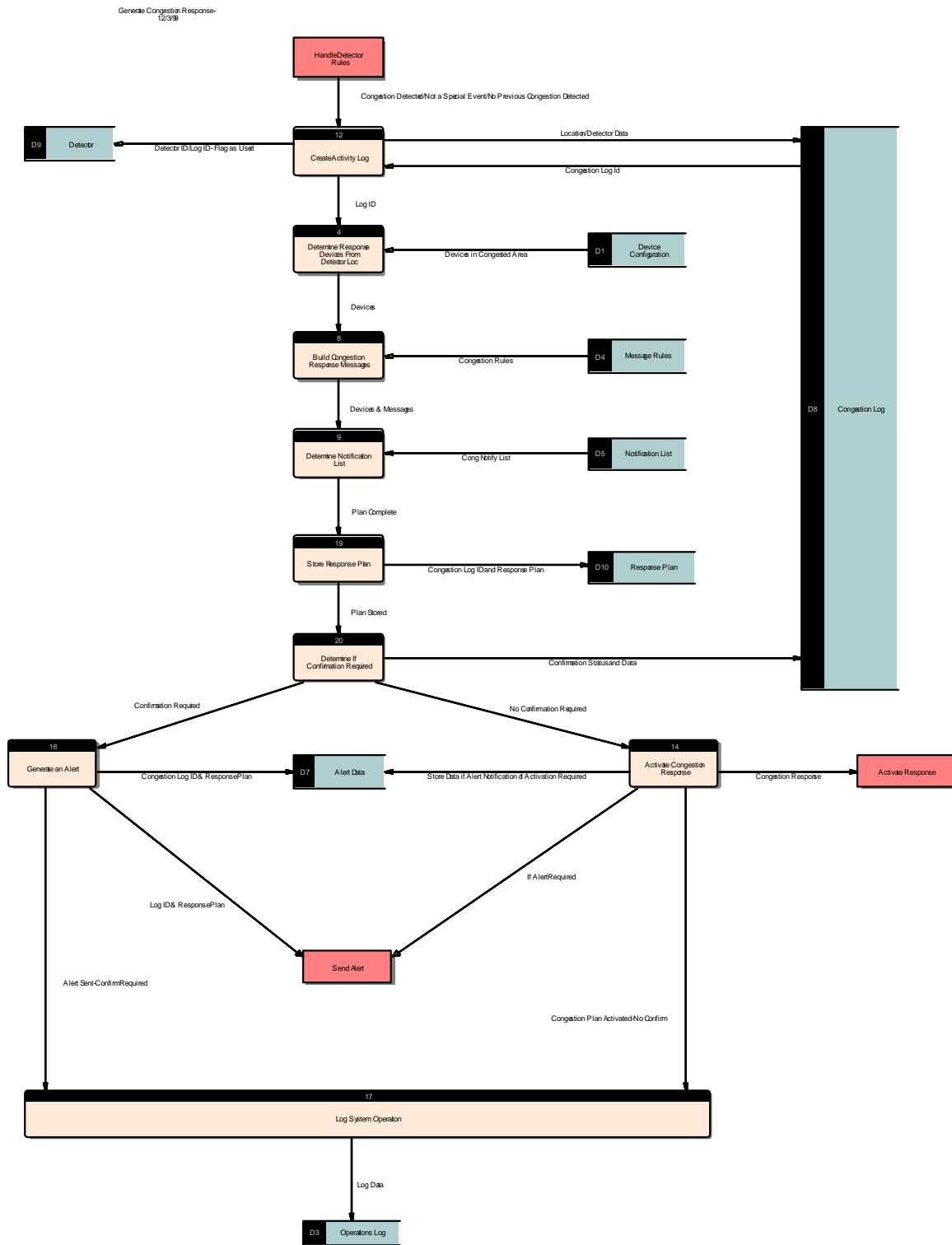
Figure 2-95. Generate Congestion Response

2.2.4.4.5.2.2   Respond to Congestion Alert

The Respond to Congestion Alert provides the capabilities to activate the system-generated response plan, which may be modified by the operator.

If the system is configured to require a confirmation of a system generated congestion response plan or notification of an activated congestion response plan, an alert has been sent and appears on the appropriate users' screen. Once a user acknowledges the alert, a congestion log is displayed with the location of the congestion, time of detection, the system generated response plan, and any other information. The operator can send the plan as is, modify and send the plan, or cancel the plan. If the congestion response plan is cancelled, the congestion log is closed. The operator may accept or modify a delay period before another congestion alert is initiated from the same device. While the congestion log is open, the detector, whose data was used in the evaluation of this congestion, will be indicated as in a congested state. No further notification of congestion is sent while the detector remains in a congested state.

CHART II Business Area Architecture Report   185   August 23, 2000
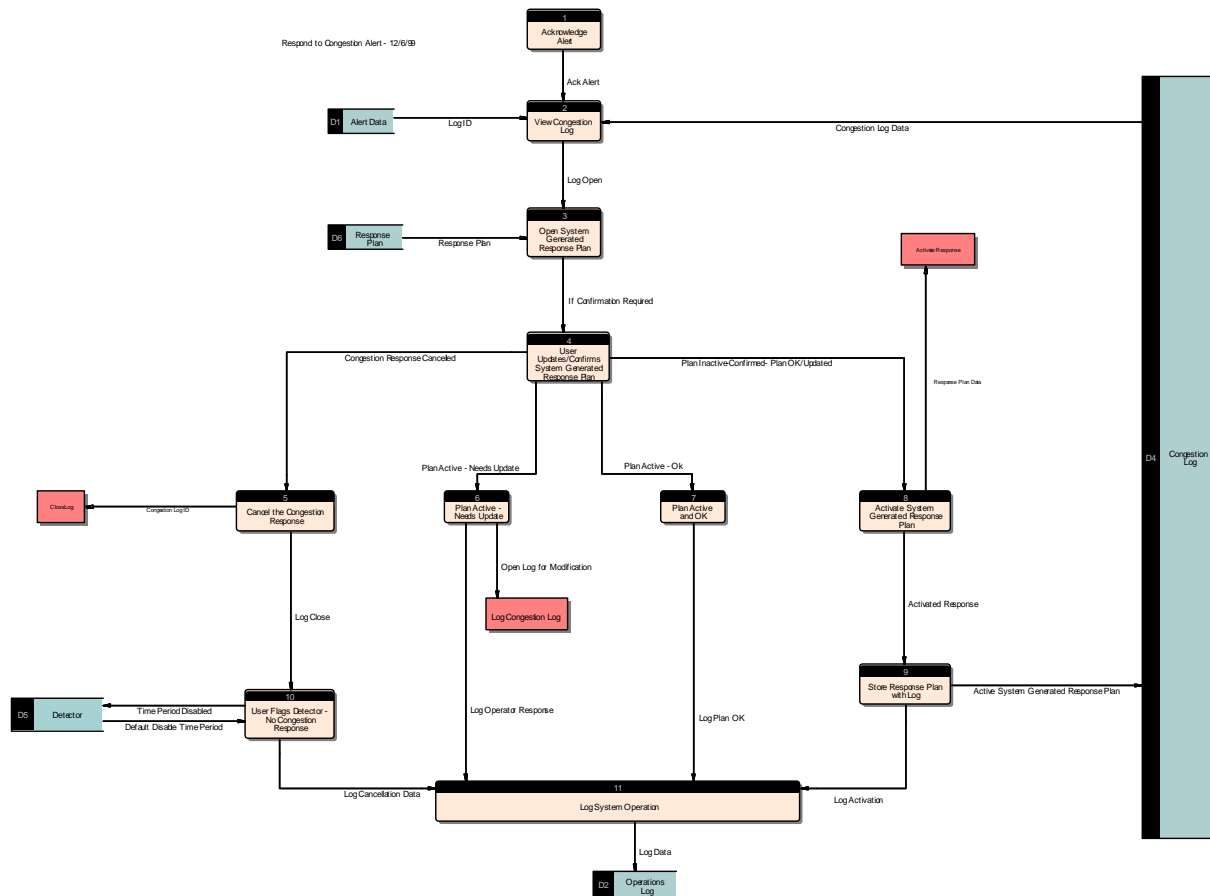
Figure 2-96. Respond to Congestion Alert

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2.2.4.4.5.2.3   Generate Incident Response

When the evaluation of incoming detector data in Handle Detector Rules shows a potential incident, and the previous reporting of the device did not show an incident, an incident log must be opened. The devices in a pre-determined radius are added to the system-generated response plan for display or broadcast of messages created from the incident response rules. Any defined notification is added to the system generated response plan. The system is configured to necessitate operator confirmation or allow activation of the plan without operator confirmation. If confirmation is not required, the system generated response plan is activated and an alert sent notifying the operator of this system action. If confirmation is required, an alert is sent to the operator(s) at the center responsible for the detector, which triggered this process.
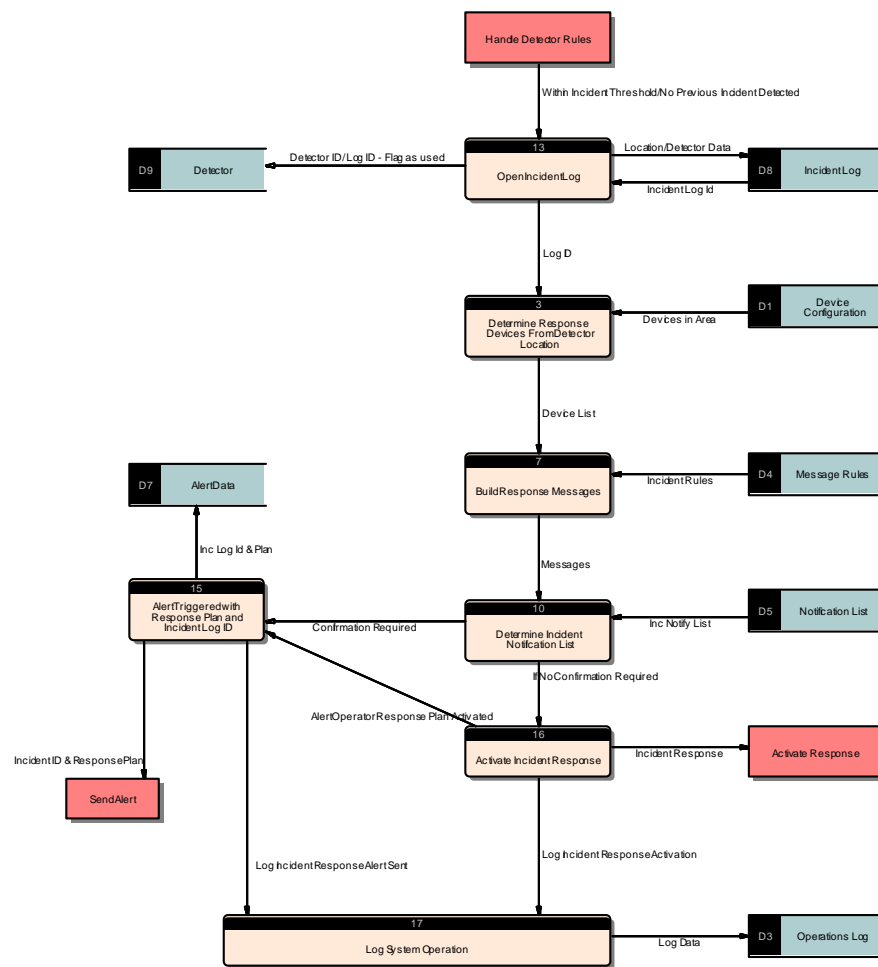
Figure 2-97. Generate Incident Response

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2.2.4.4.5.2.4   Respond to Incident Alert

If confirmation is needed for activating an incident response plan, an alert is sent and appears on the appropriate user's screen. Once a user clicks on the alert, the nearest camera is located, displayed on the user's monitor, and control is given to the user. If another operator is using it, that user is relieved of control and control is given to the operator handling this incident alert. An incident log is opened and displayed with the location of the incident, time of detection, current weather conditions, the system generated response plan, and other information. Based on the operator's verification of the incident, the operator can send the system generated response plan, modify and send the response plan, or cancel the plan. If the plan is cancelled the incident log is closed. While the log is open, the detector responsible for the data used in the evaluation of this incident will be in an incident state.
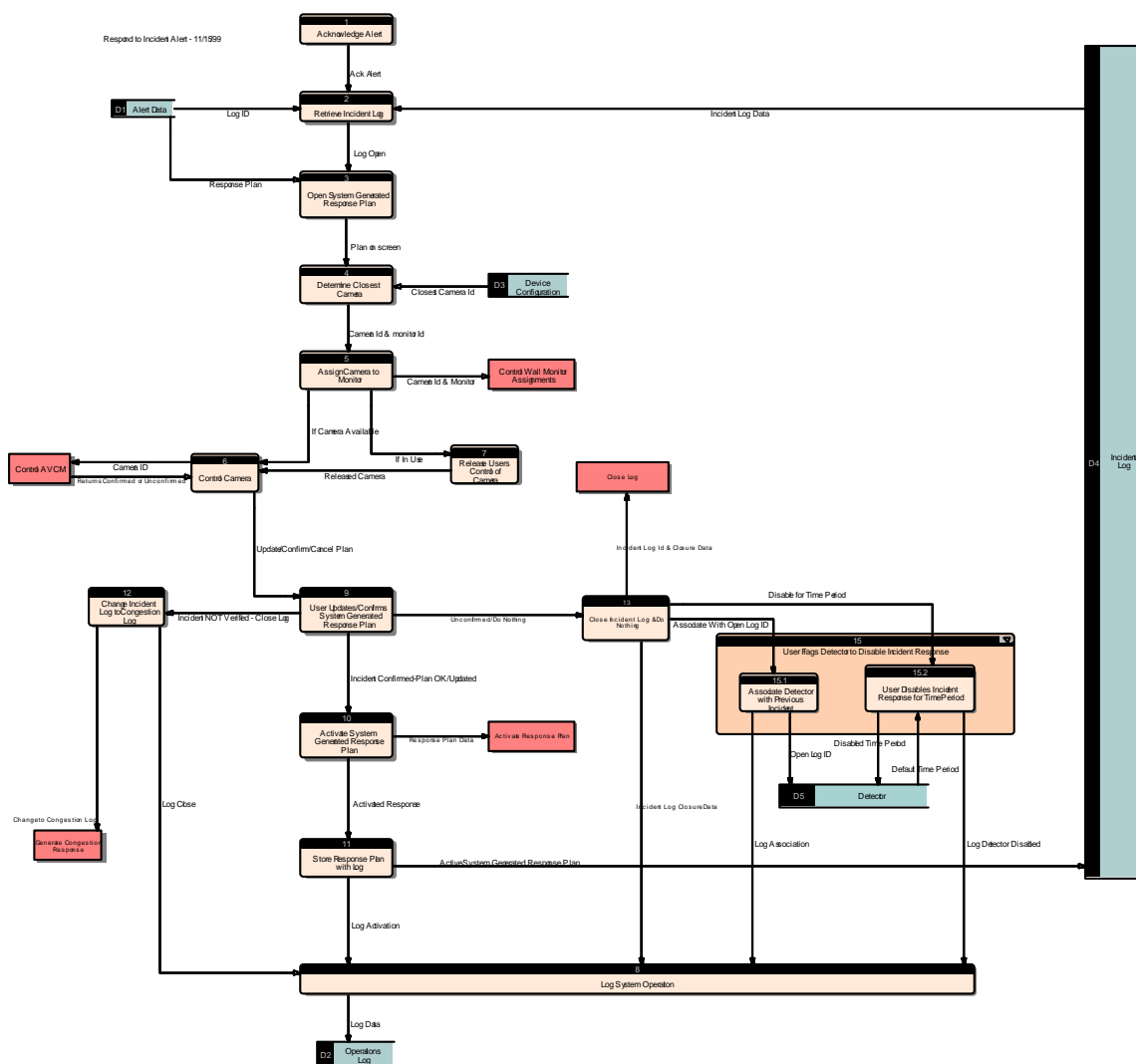
Figure 2-98. Respond to Incident Alert

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2.2.4.4.5.2.5 Activate Response Plan

Once the response plan is created, and confirmed if necessary, the plan is activated. The commands are read from the plan and executed in sequence. Each command in the plan is executed by interfacing with its related process/application and all arbitration rules apply.
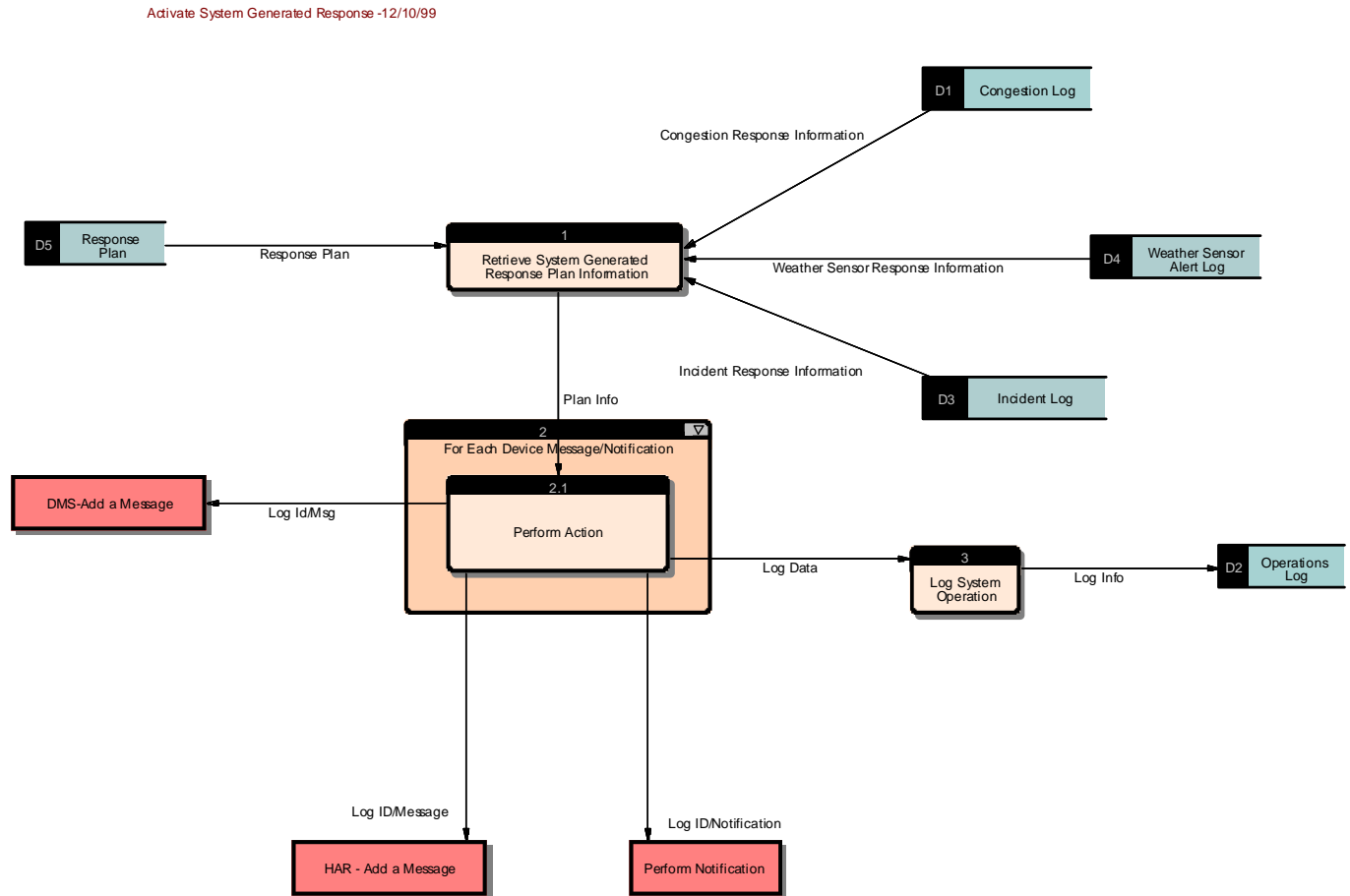
Figure 2-99. Activate Response Plan

2.2.4.4.6 Equipment

The Equipment Processes group is used for the following functions: to maintain equipment inventories at Maryland SHA maintenance shops used for CHART incident response, to maintain the status of that equipment, to alert shops of necessary updates on associated equipment status.

2.2.4.4.6.1 Maintain Equipment Inventory

The Maintain Equipment Inventory process is a centrally controlled function used to add, modify, or delete equipment inventories for each maintenance shop responsible for assisting with incident response. The inventory represents all pieces of equipment regardless of status.
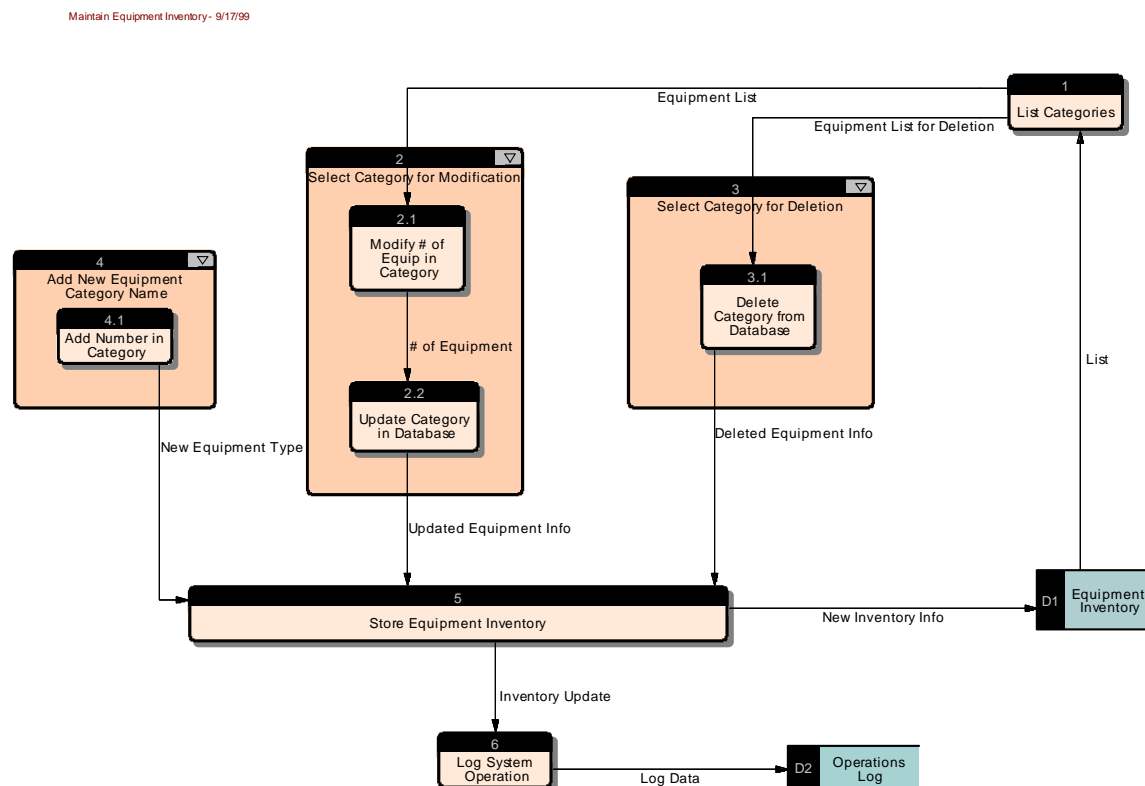
Figure 2-100. Maintain Equipment Inventory

2.2.4.4.6.2 Maintain Equipment Status

The Maintain Equipment Status process is used by the individual Maryland SHA maintenance shops to update the status of their equipment. This is vital because, as a CHART operator is notifying a shop to dispatch equipment to an incident, he/she needs to know what equipment (*i.e.,* front-end loader) is there and whether or not it's available.
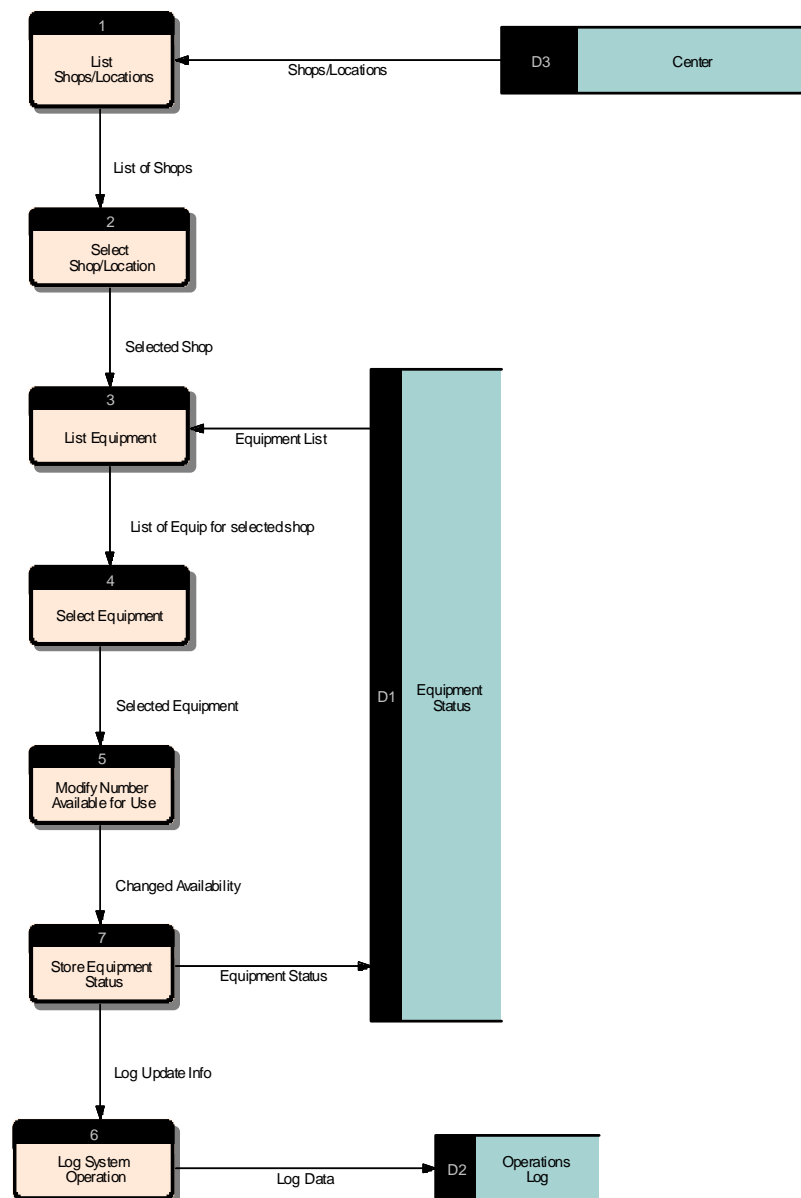
Figure 2-101. Maintain Equipment Status

2.2.4.4.6.3 Alert for Delinquent Equipment Status

The Alert for Delinquent Equipment Status process is used to assure the accuracy of information reported by the maintenance shops. On a pre-determined schedule, the equipment status for each shop is polled by the CHART system to see if the equipment status has been updated within the given parameters. If not, an alert is sent to the shop, notifying them that the status needs to be updated.
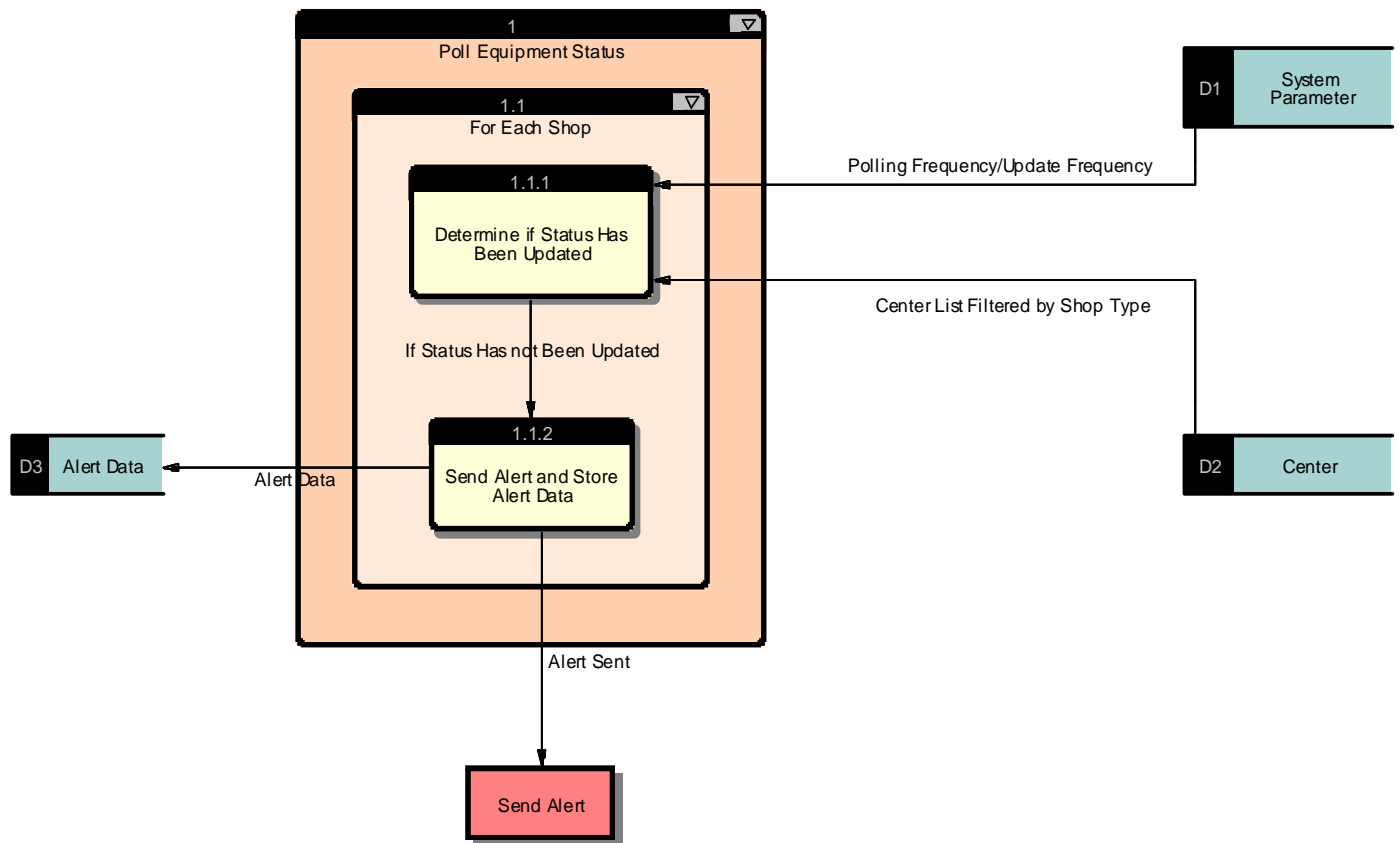
Figure 2-102. Alert for Delinquent Equipment Status

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2.2.4.4.6.4 Respond to Delinquent Equipment Status Alert

The Respond to Delinquent Equipment Status Alert process allows the shop to acknowledge receipt of the alert, and then update equipment status.

10/6/99
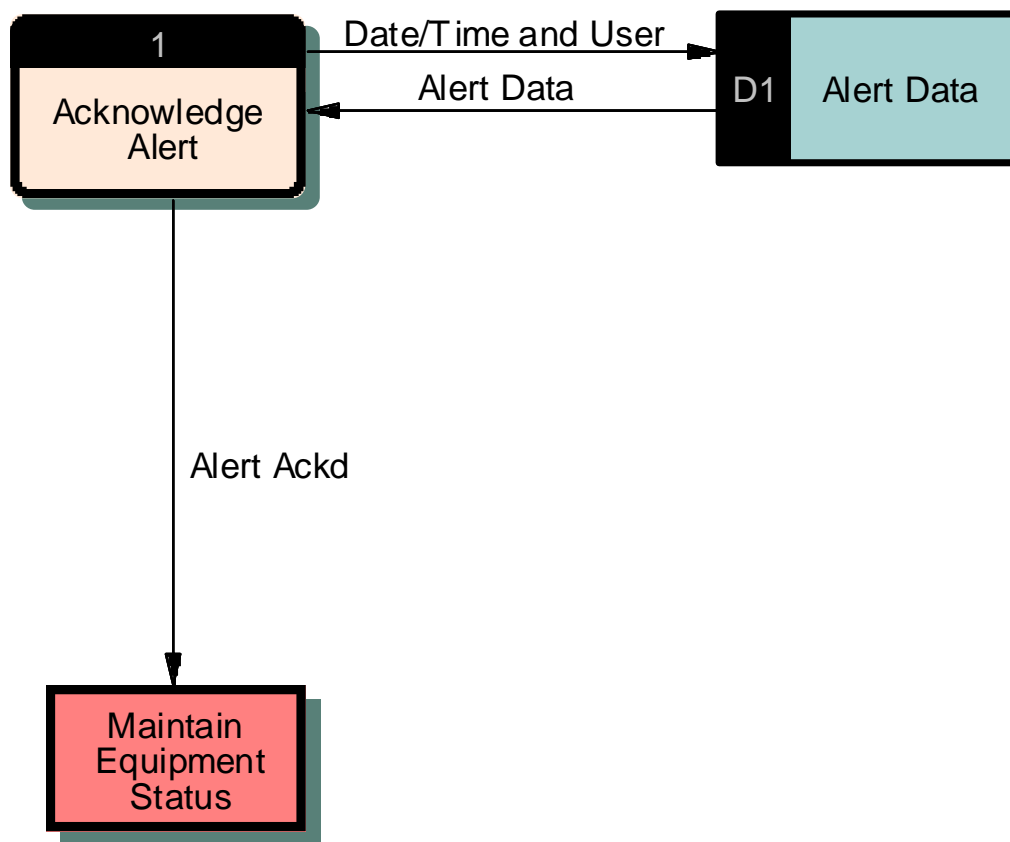
Figure 2-103. Respond to Delinquent Equipment Status Alert

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2.2.4.4.7 Signals

The Signals process group is used to receive periodic data for each of the signal devices, respond to signal failure alerts, and store individual signal device and controller data to the archive.

There are a couple issues with signals to be reviewed before the following business processes can be implemented as defined. (1) Current communications with traffic controllers is via dial-up modems and would be cost prohibitive to poll on a frequent basis – there should be a change in communications before implementing these processes. (2) There is an effort underway to convert all the signal controllers to adaptive controllers, hence these processes do not identify a method to change signal timings. Both of these issues should be reviewed during detailed design to verify their status.

2.2.4.4.7.1 Handle Signal Polling Data

The Handle Signal Polling Data process is used to receive data from FMS or Econolite in order to analyze the flow of traffic and to alert individuals if traffic flow thresholds reach unacceptable pre-determined parameters. As data is received from FMS or Econolite, either flow data or a failure status is sent to the CHART system. If a failure is reported, the failure is logged in the failure log and an alert is sent. The response to the failure alert will be handled by the Respond to Device Failure Alerts process (Section 2.2.4.2.2.6). The flow data received will be compared to pre-determined system parameters. If a determination is made that the flow falls below the thresholds, the device status will be updated and an alert will be sent

This process will require a thorough review during detailed design to determine the current communications capabilities.

CHART II Business Area Architecture Report   194   August 23, 2000
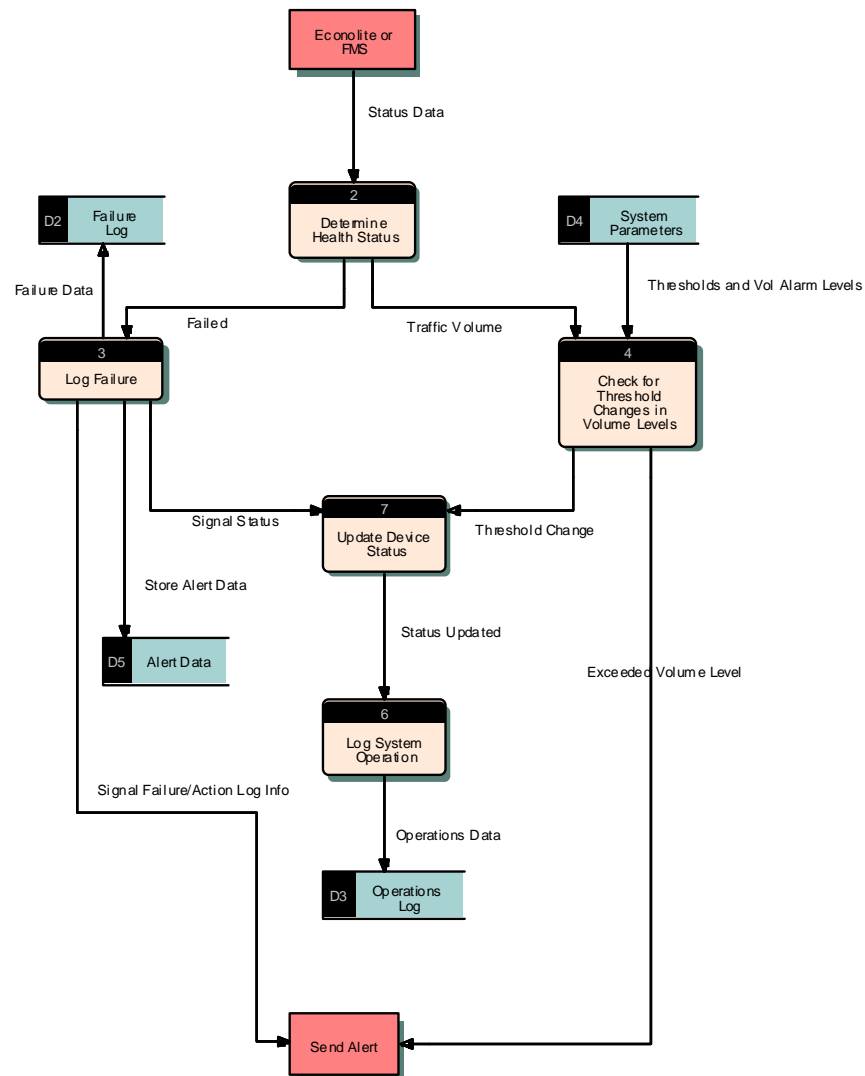
Figure 2-104. Handle Signal Polling Data

2.2.4.4.7.2 Respond to Exceeded Signal Threshold Alert

The Respond to Exceeded Signal Threshold Alert process is used to react to a situation where the traffic signal data determines there is an abnormal traffic flow. Once the CHART II operator acknowledges the alert, an Action Log is opened allowing the operator to record data about the situation. In addition, the traffic flow data is displayed.

Respond to Exceeded Volume Threshold Alert-10/21/99
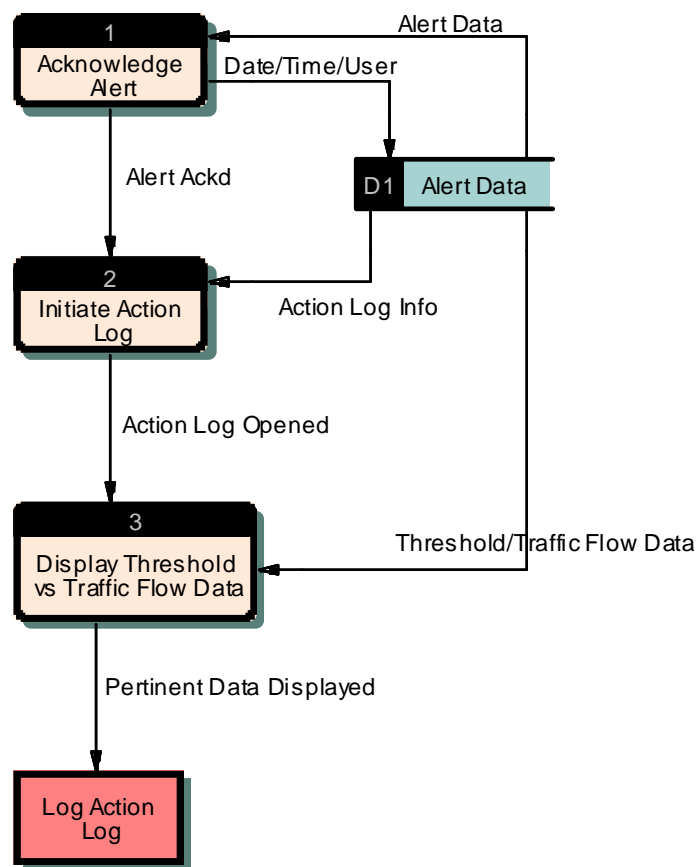
Figure 2-105. Respond to Exceeded Signal Threshold Alert

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2.2.4.4.7.3 Download Signal Data

The Download Signal Data process is a custodial process performed once a day to archive data for each signal device. At a specified time, based on system parameters, the data for each signal device is retrieved. If there is a failure of the device, the failure is logged in the Failure Log and the device status is updated. If there is a command failure, it is logged in the Operations Log. If the attempt to retrieve the data is successful, the device traffic data is manipulated, summarized, and stored in an Archive data store.

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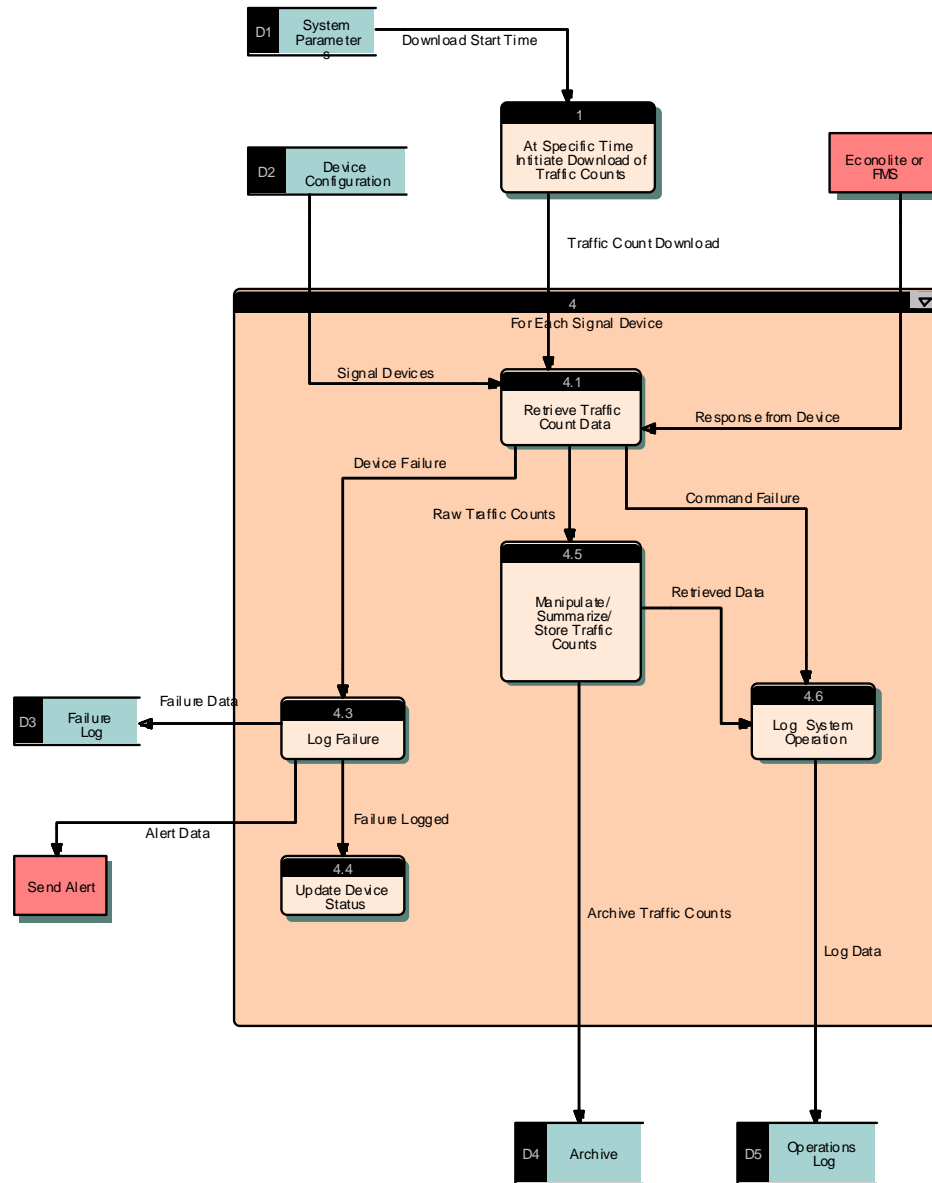
Figure 2-106. Download Signal Data

2.2.4.4.8   AVL

The Automated Vehicle Location (AVL) processes group is comprised of processes that poll the AVL devices which are on-line, processes AVL messages input by the operators of the devices, and handles responses to alerts as a result of specific AVL messages which are transmitted.

2.2.4.4.8.1   Handle AVL Polling Results

The Handle AVL Polling Results process updates the results of periodic health checks of online AVL devices. The frequency of polling these devices is controlled by System Parameters. The AVL package will perform the actual communication with the devices at the specified frequency and pass the resulting health check information to CHART II. If the device is okay (within acceptable diagnostic parameters), the status of the device is updated to indicate a healthy status and the date/time stamp of the last poll. If the device is not okay (outside acceptable diagnostic parameters), the failure information is written to the Failure Log, an alert is sent, and the status of the device is updated to reflect a failure status and the date/time stamp of the last poll. The response to the failure alert will be handled by the Respond to Device Failure Alerts process at paragraph 2.2.4.2.2.6.

Handle AVL Polling Results - 12/15/99
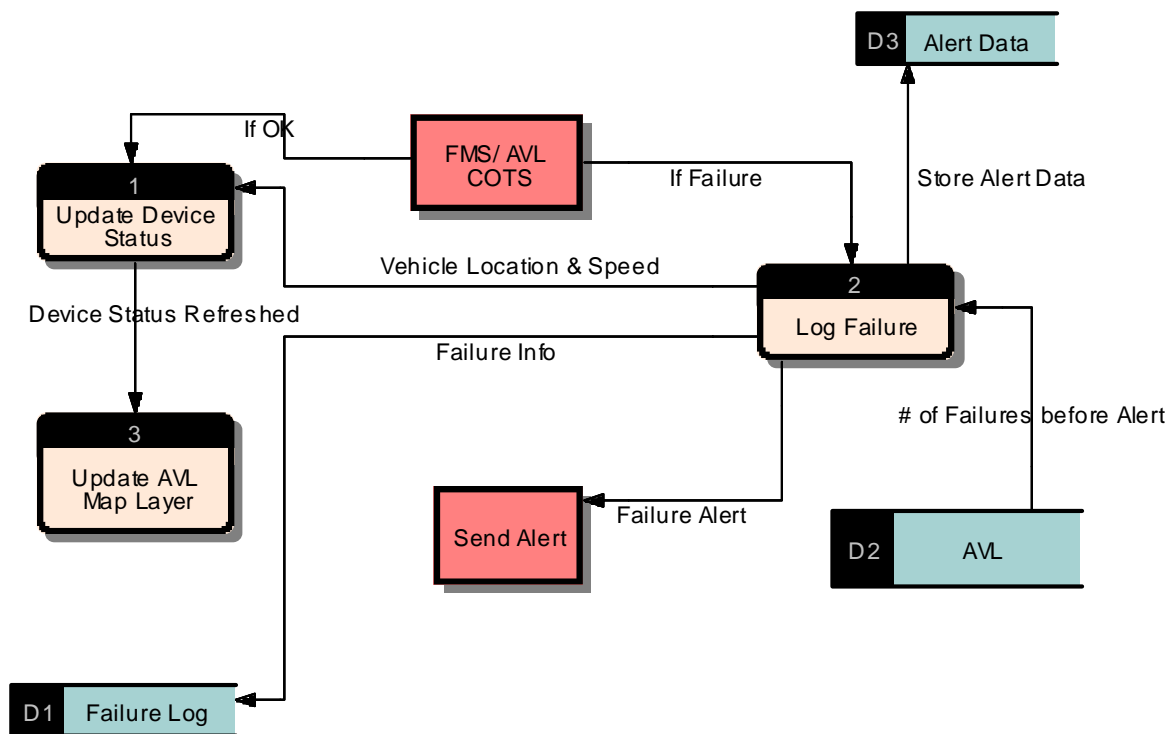
Figure 2-107. Handle AVL Polling Results

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2.2.4.4.8.2 Perform AVL Function Processing

The following Perform AVL Function Processing processes are used to take the information that has been received by the AVL devices, and process accordingly. Once the information has been received, the incoming message is logged, the vehicle and operator call sign data is retrieved, and the message type is determined for further processing. The five main messages to be handled further are:

- In/Out of Service

- Mayday

- Arrival On-Scene

- Assisting Disabled Vehicle

- Assisting Disabled CHART Vehicle

- Available

Implementation Considerations:

The AVL solution is seen as being a COTS package, which initially will have limited functionality. In the future, the AVL will interface more intelligently to allow the status from the console to add to open logs, as well as allow for input of more message types and specific data types.

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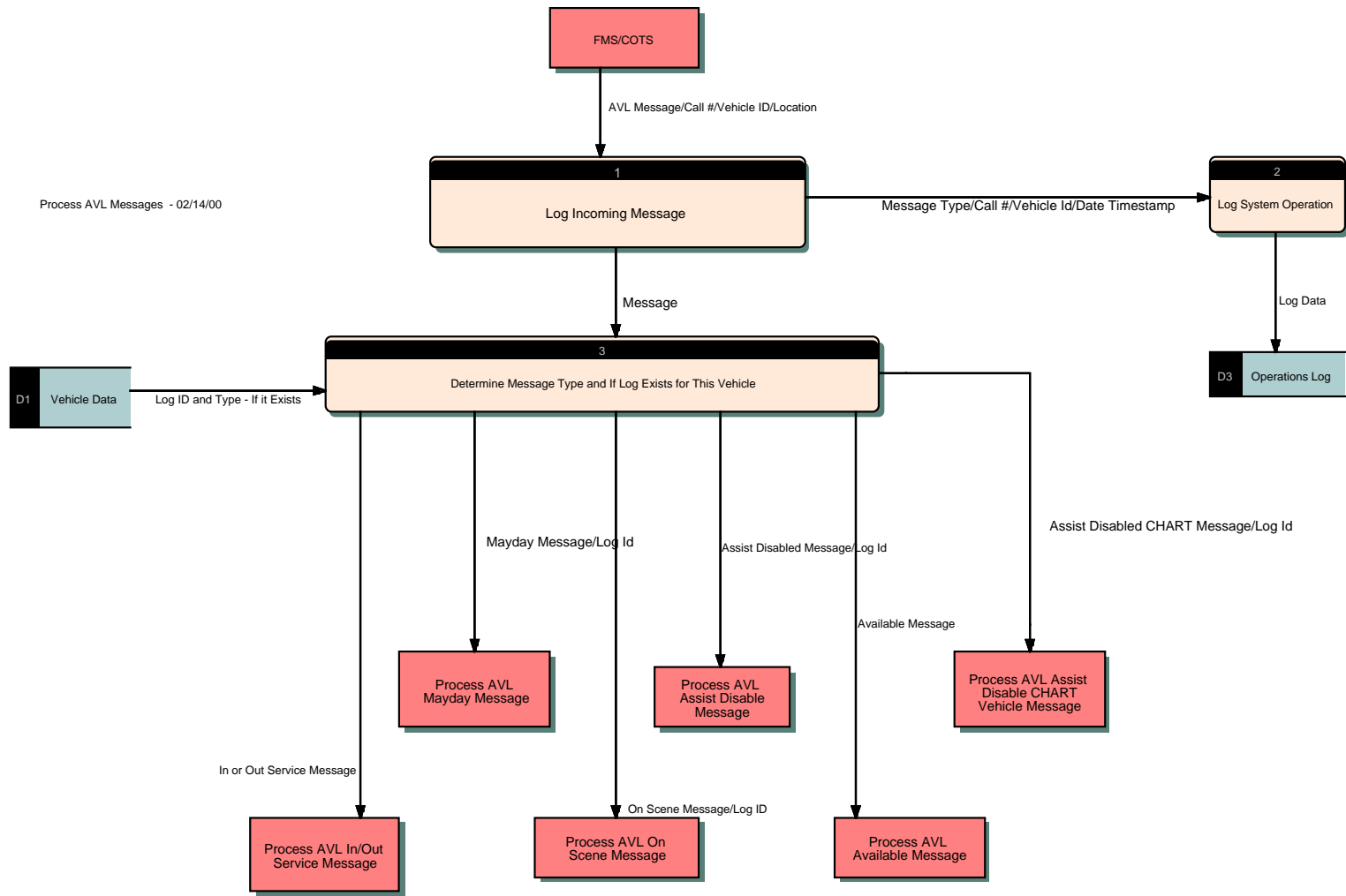
Figure 2-108. Perform AVL Function Processing

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2.2.4.4.8.2.1   Process AVL In/Out of Service Message

The Process AVL In/Out of Service Message process is used by the system to update the CHART II system when a vehicle operator has chosen either the *In Service* or *Out of Service* functions from the AVL device. The notification is received into the CHART II system and is logged in the Communications Log. The vehicle status and operator call sign is stored in the Vehicle Data store. Whether the In- or Out of Service functions are chosen, the device will either be placed On- or Off-Line to either start or stop the polling process of the device.

Assumption: Operator call-sign will be captured by the AVL device system.
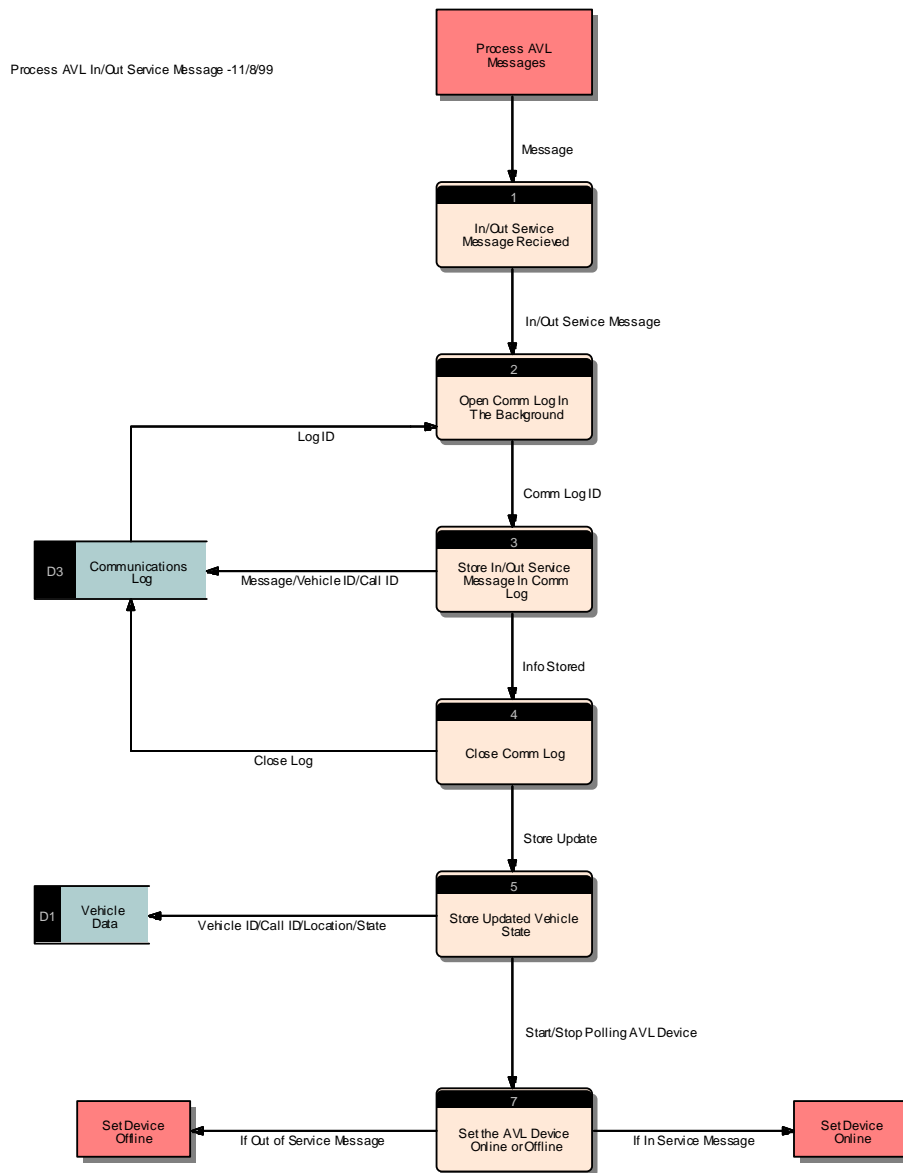
Figure 2-109. Process AVL In/Out Service Message

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2.2.4.4.8.2.2 Process AVL Mayday Message

The Process AVL Mayday Message process is used by the system to notify the CHART II operators when a vehicle operator has activated the Mayday functions from the AVL device (or from some hidden button). The notification is received into the CHART II system and logged in the Incident Log. An alert is sent to the CHART II operators, and the vehicle status and operator call sign is stored in the Vehicle Data store.
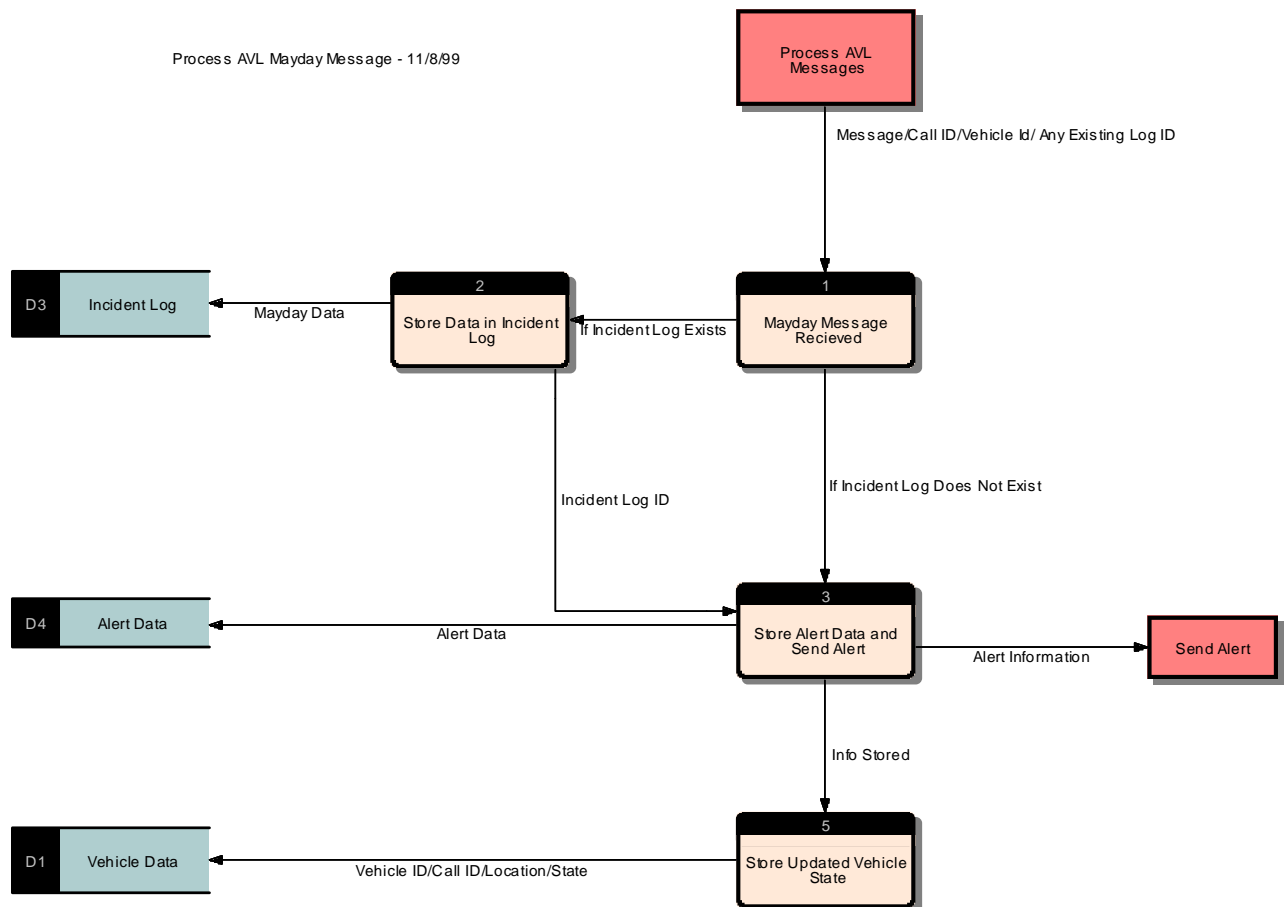
Figure 2-110. Process AVL Mayday Message

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2.2.4.4.8.2.3 Process AVL Arrival On-Scene Message

The Process AVL Arrival On-Scene Message process is used by the system to notify the CHART II operators when a vehicle operator has chosen the Arrival On-Scene function from the AVL device. The notification is received into the CHART II system and is logged in the Incident Log, Disabled Vehicle Log, or Action Log for which the vehicle was dispatched. If a log does not exist for which the vehicle was dispatched, an alert is sent to the CHART II operators, and the vehicle status and operator call sign is stored in the Vehicle Data store.
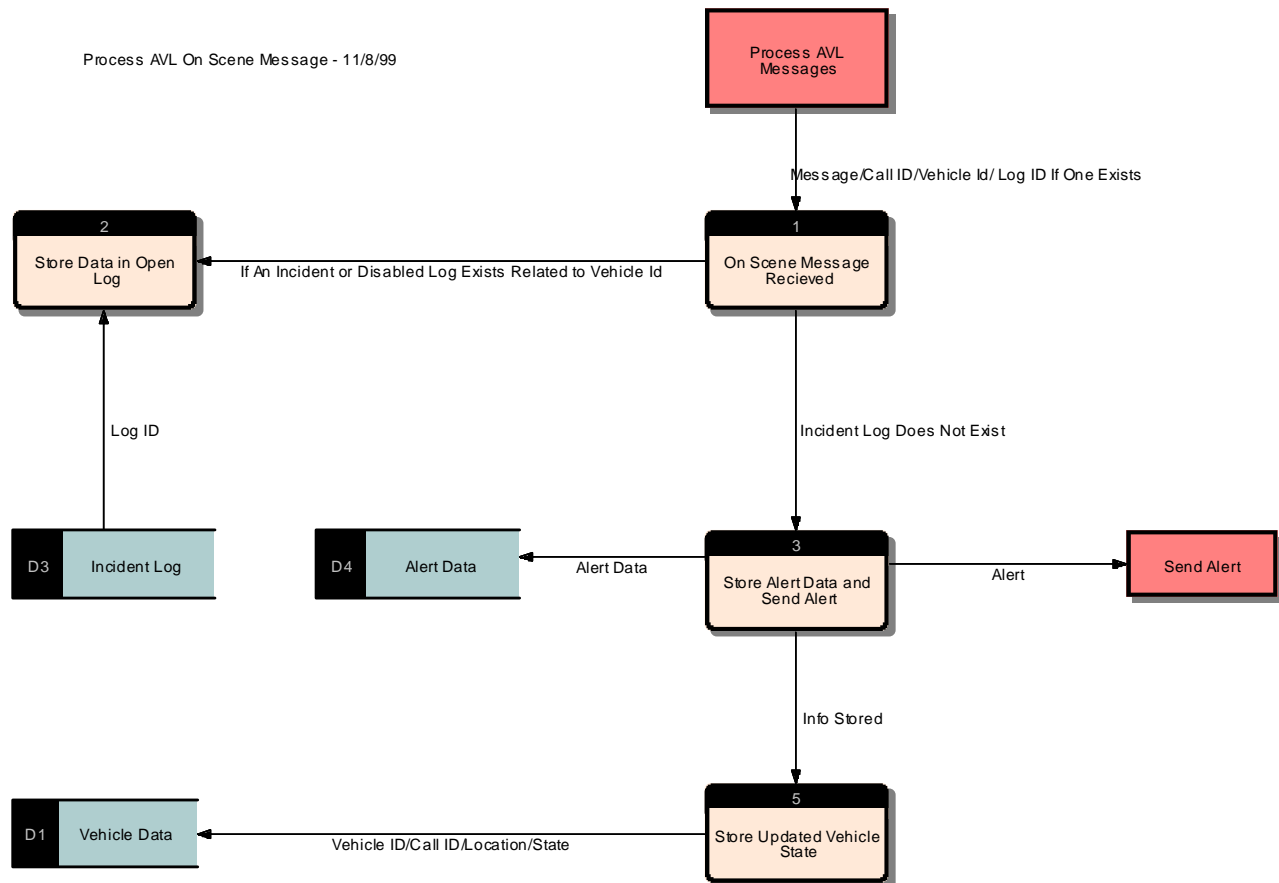
Figure 2-111. Process AVL Arrival On-Scene Message

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2.2.4.4.8.2.4 Process AVL Assist Disabled Vehicle Message

The Process AVL Assist Disabled Vehicle Message process is used by the system to notify the CHART II operators when a vehicle operator has chosen the Assist Disable Vehicle function from the AVL device. The notification is received into the CHART II system and logged in the Disabled Vehicle Log if a log entry has already been opened. If a log does not exist, then a new one is opened. An alert is sent to the CHART II operators, and the vehicle status and operator call sign are stored in the Vehicle Data store.

In evaluating an AVL solution, it would be desirable that the solution allowed for the driver to input the type of assistance provided to the disabled vehicle.
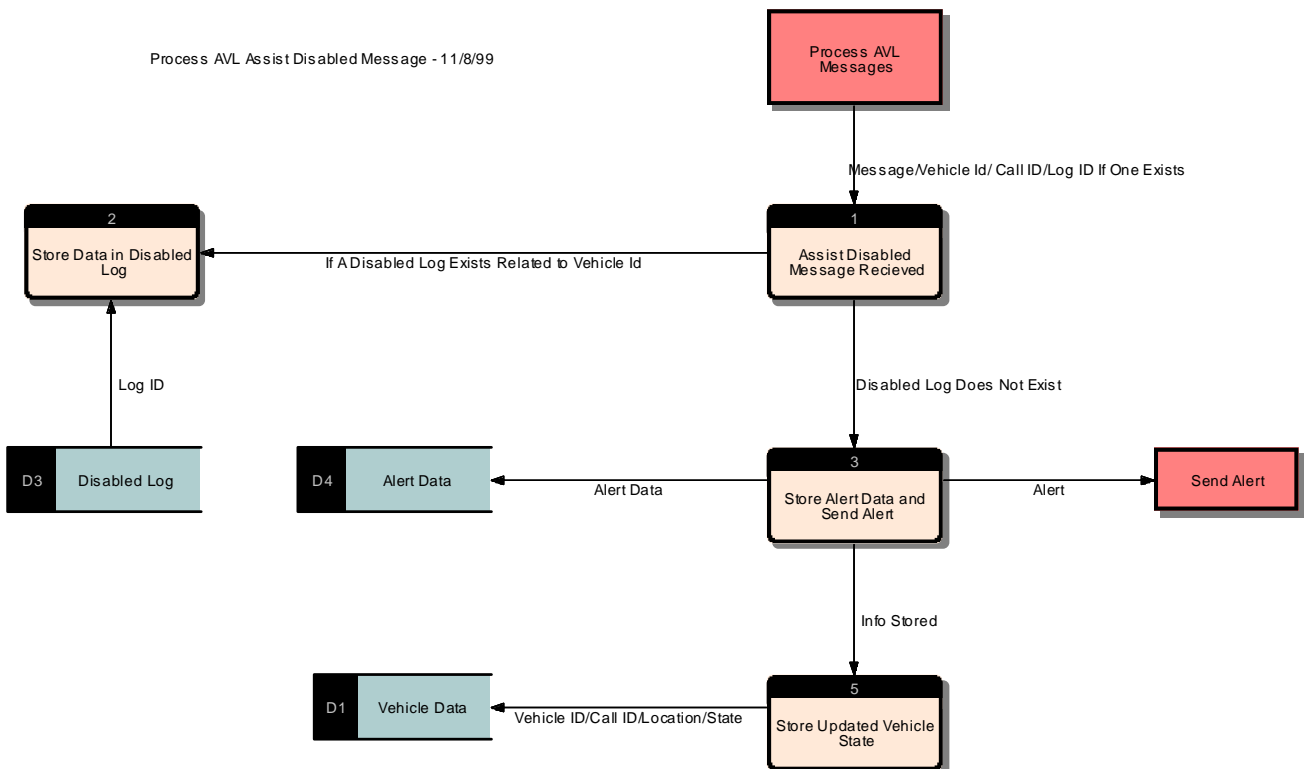
Figure 2-112. Process AVL Assist Disabled Vehicle Message

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2.2.4.4.8.2.5 Process AVL Assist Disabled CHART Vehicle Message

The Process AVL Assist Disabled CHART Vehicle Message process is used by the system to notify the CHART II operators when a CHART vehicle operator has chosen the Assist Disabled CHART Vehicle function from the AVL device. The notification is received into the CHART II system and logged in the Disabled Vehicle Log if a log entry has already been opened. If a log does not exist, then a new one is opened. An alert is sent to the CHART II operators, and the vehicle status and operator call sign are stored in the Vehicle Data store.
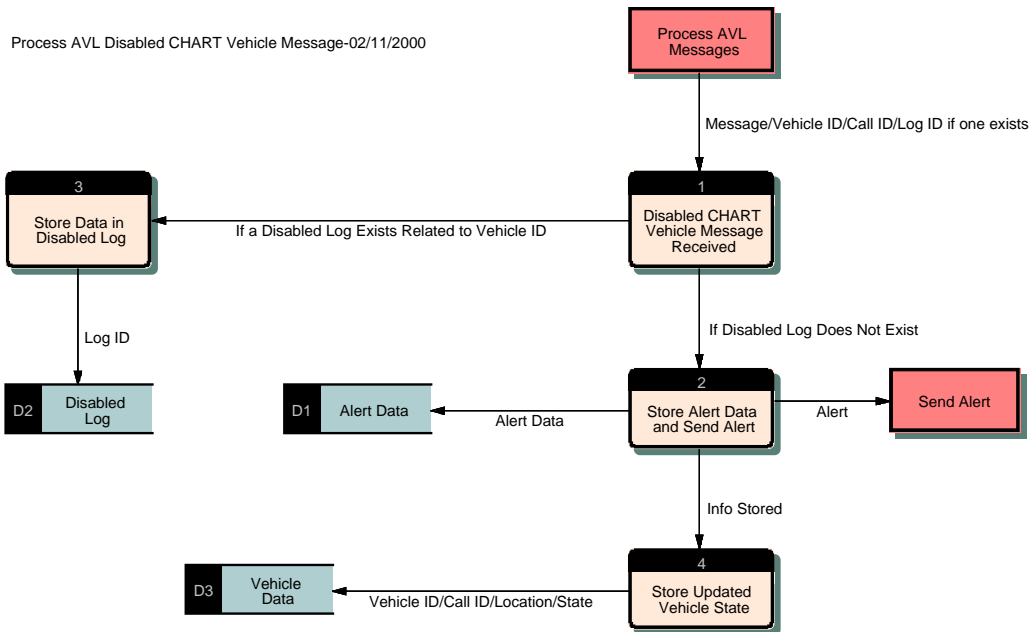
Figure 2-113. Process AVL Assist Disabled CHART Vehicle Message

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2.2.4.4.8.2.6 Process AVL Available Message

The Process AVL Available Message process is used by the system to notify the CHART II operators when a vehicle operator has chosen the Available function from the AVL device. This selection is used when a vehicle operator is leaving the scene in response to an Incident Log, Action Log, or Disabled Vehicle Log. It lets the CHART II operators know the driver is available to respond to other calls. The notification is received into the CHART II system where vehicle status and operator call sign are stored in the Vehicle Data store.
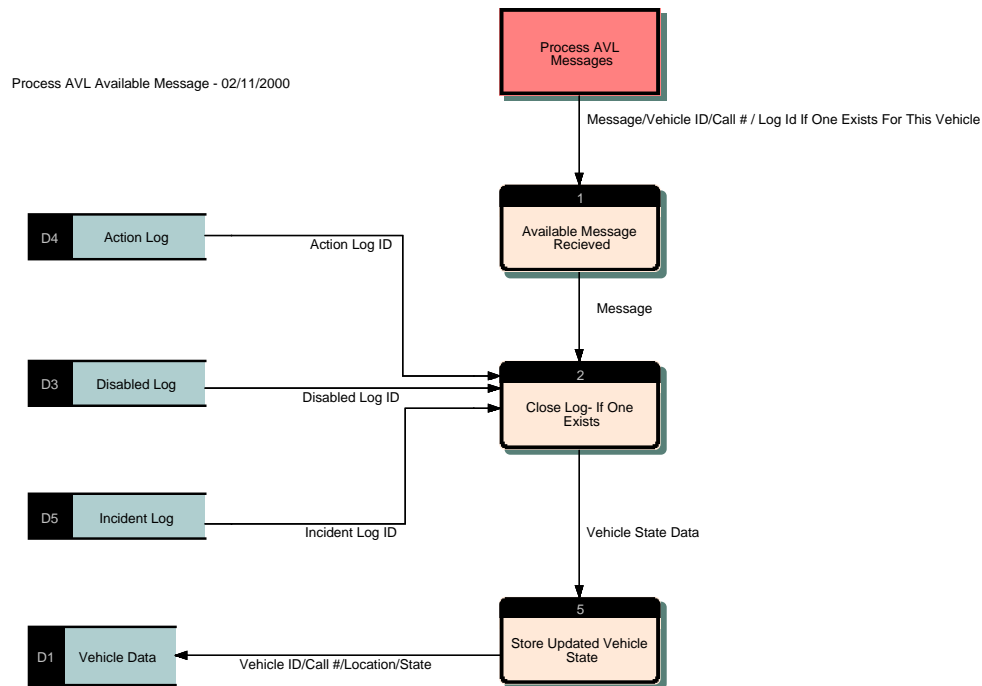
Figure 2-114. Process AVL Available Message

2.2.4.4.8.3 Respond to AVL Alerts

The Respond to AVL Alerts processes which follow are used to take the information received from the alerts sent by the CHART II system display the alerts on the work station of the CHART II operators.

2.2.4.4.8.3.1 Respond to AVL Mayday Alert

The Respond to Mayday Alert process is used when a person using an AVL device selects the Mayday button. At the time the alert is acknowledged, the following information will be displayed in graphical form on the map:

- Icon showing vehicle location

- Operator call sign

- Vehicle ID Number

- Mayday status

- Last message transmitted from driver, plus time of message

In addition, a pop-up window will be displayed on the screen of the center and Maryland State Police barracks responsible for responding to this AVL at its current geographical location. As soon as the center operator acknowledges the alert, an Action Log will be displayed showing the current information. As the situation progresses, the operator at the center will key the pertinent information into the Action Log and close the log when appropriate.

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Respond to Mayday Alert from AVL-10/20/99
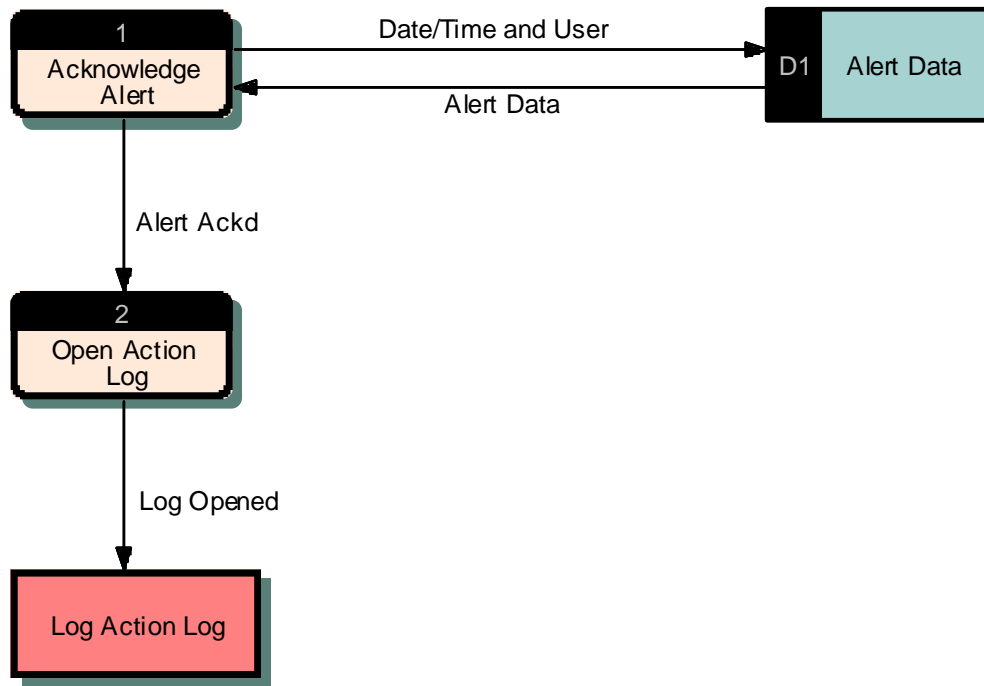
Figure 2-115. Respond to Mayday Alert from AVL

2.2.4.4.8.3.2   Respond to AVL Arrival On-Scene Alert

The Respond to Arrival On-Scene Alert process is used when a person using an AVL device selects the Arrival On-Scene button.

An alert will be shown to the CHART II operator at the center. Once the center operator acknowledges the alert, either a new Incident Log will be displayed showing the current information, or an existing Log will be opened which corresponds with the driver who was dispatched and has arrived on the scene of the incident. The driver will contact the center and report pertinent information (*i.e.,* vehicle tag information, vehicle description) to be added to Log. As the situation progresses, the operator will input additional information into the Log and close it when appropriate.

Respond to Arrival On-Scene Alert from AVL-11/15/99
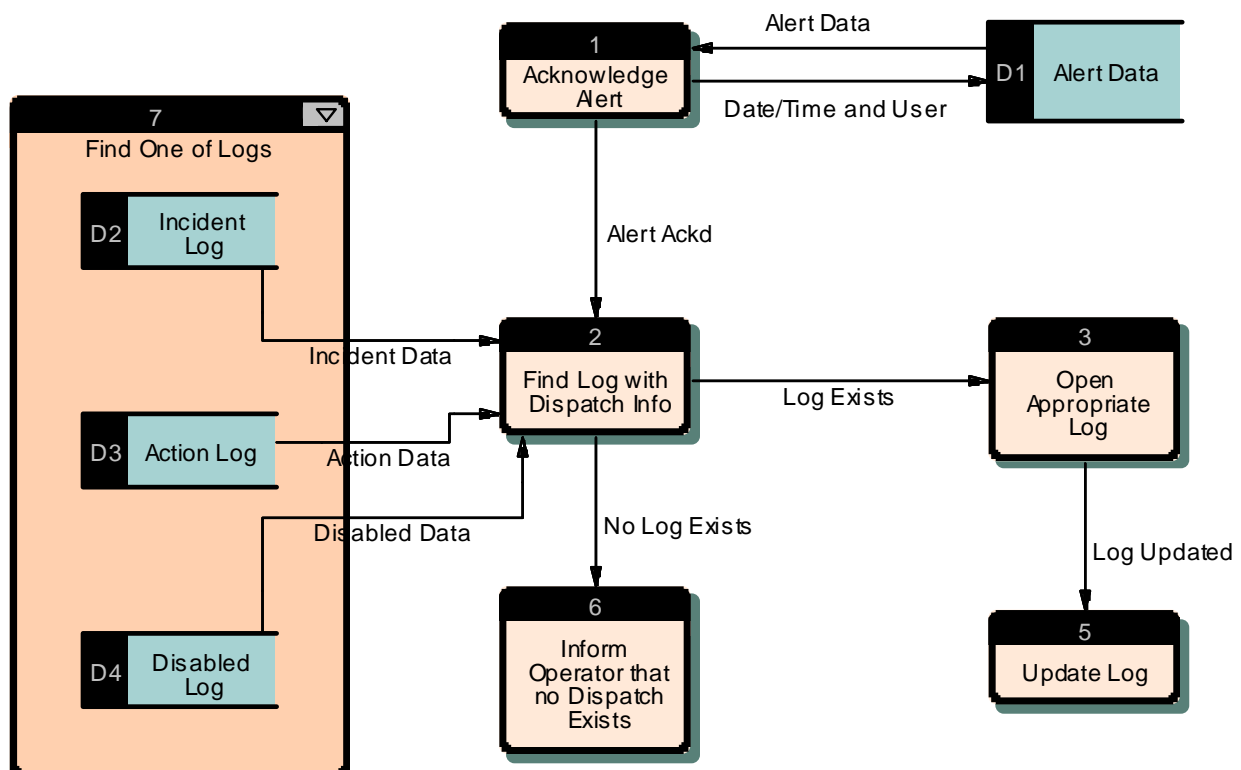
Figure 2-116. Respond to Arrival On-Scene Alert from AVL

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2.2.4.4.8.3.3 Respond to AVL Disabled Vehicle Alert

The Respond to Disabled Vehicle Alert process is used when a person using an AVL device selects either the Disabled Vehicle or the CHART Disabled Vehicle button.

An alert will be shown to the CHART II operator at the center responsible for the AVL equipped vehicle. Once the center operator acknowledges the alert, a Disabled Vehicle Log will be displayed showing the current information. If the alert is for a CHART vehicle, the vehicle data (Vehicle ID, Call ID, Location) will be inserted into the log automatically. If the disabled vehicle is a non-CHART vehicle, the driver will contact the center and report pertinent information (*i.e.,* vehicle tag information, vehicle description) for addition to the Log. As the situation progresses, the operator will input additional information into the Log and close it when appropriate.

Respond to Disabled Vehicle Alert from AVL-10/20/99
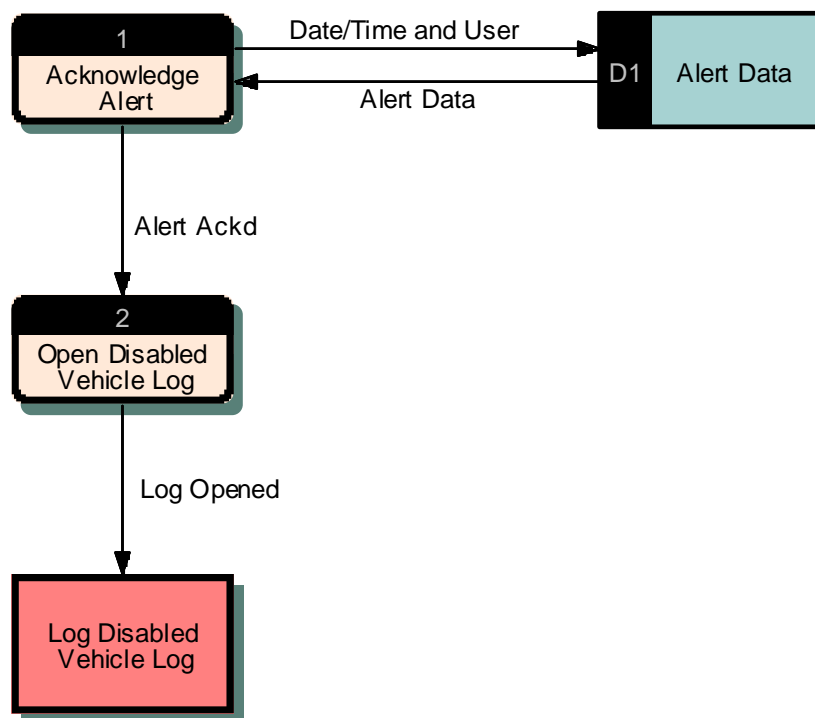
Figure 2-117. Respond to Disabled Vehicle Alert from AVL

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2.2.4.5 Alerts

The Alerts processes includes the common processes that physically send alerts required by other processes and, if required by the alert type, checks for the need to re-route/re-send alerts due to a *non-response* to an alert.

Alerts - 11/16/99
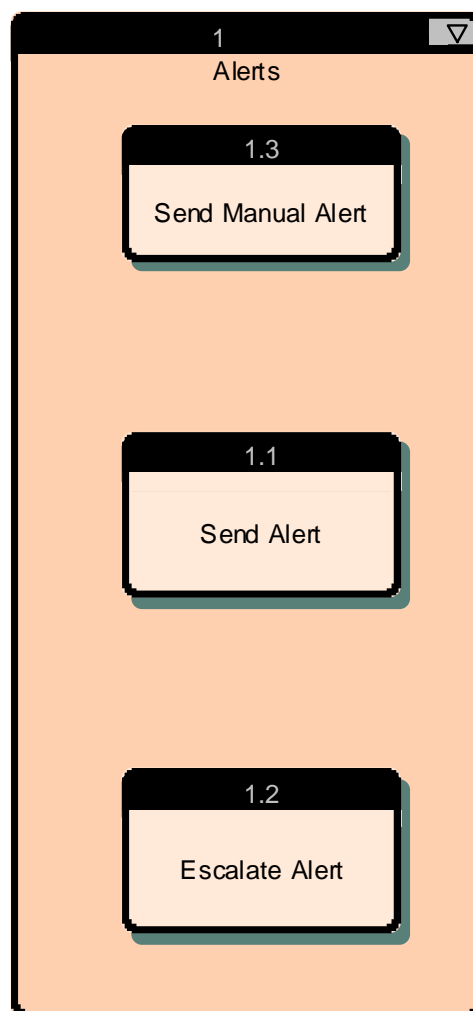
Figure 2-118. Alerts

2.2.4.5.1   Send Manual Alert

The Send Manual Alert process is used by a CHART II operator to notify one of the shops of the need for assistance during the following instances: disabled vehicle, congestion, special event, weather sensor alert, weather advisory, action, or incident. While the CHART II operator is in the associated log, the operator will have an option to Send a Manual Alert. Once this selection is made, the operator is able to choose who will be alerted, what type of alert will be sent, and can input additional text that the shop being notified will receive. When the CHART II operator is satisfied with the alert to be generated a 'Send Alert' selection will be made, the alert will be sent, and the operator returns to the associated log with the updated information about the alert sent.
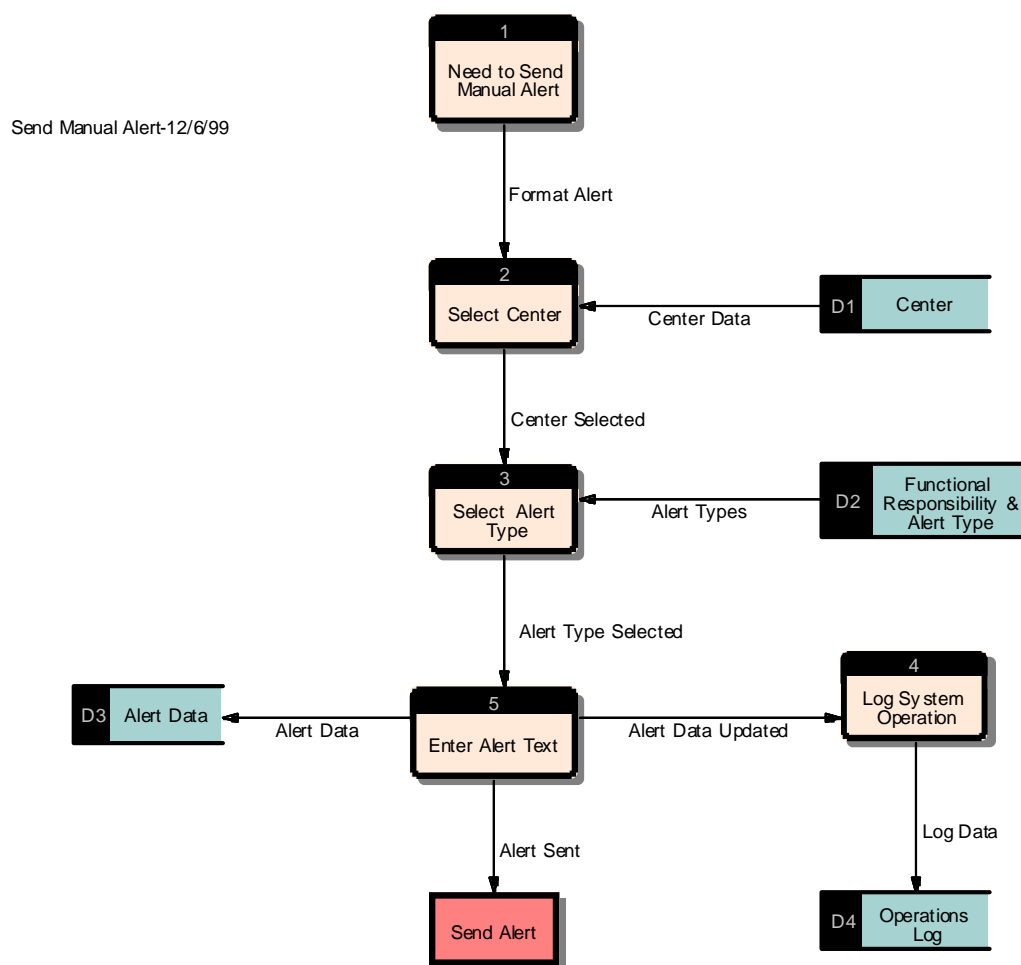
Figure 2-119. Send Manual Alert

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2.2.4.5.2   Send Alert

The Send Alert process is used to send alerts to operators from various processes. Once it has been determined an alert must be sent, the alert type and center information is retrieved; this establishes where the alert must be sent. Based on the information received, the system retrieves the users that are logged in at that location. If no users with the appropriate functional rights to handle the alert are logged on, an alert failure is recorded and the next center in the hierarchy is alerted through the Escalate Alert process. If no users are currently logged on, but the alert type can wait to be received until a user *does* logon, the system will display the alert to the next user to logon. If there are users logged on, the alert is sent and displayed on the operators' screen.

Once a user acknowledges the alert, it is removed from the screen of other users at the receiving center. All alerts are sent to a receiving center except the weather alert from the National Weather Service. This alert will be sent to all users with the exception of the media. The following list identifies the types of Alerts to be generated from the CHART II system :

- Action from open report
- Alarm Timeout Alarm
- Device Failure from System
- Equipment Request from open report
- Transfer of Resources
- Incident from open report (roadwork)
- Incident from Detector
- Incident from AVL
- Disabled from AVL
- Disabled CHART Vehicle from AVL
- Mayday from AVL
- Congestion from Detector
- Response Plan Generation
- Weather forecast
- Weather Sensor
- CHART II infrastructure failure
- External source, incident
- Delinquent Equipment Status

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Figure 2-120. Send Alert

CHART II Business Area Architecture Report   215   August 23, 2000
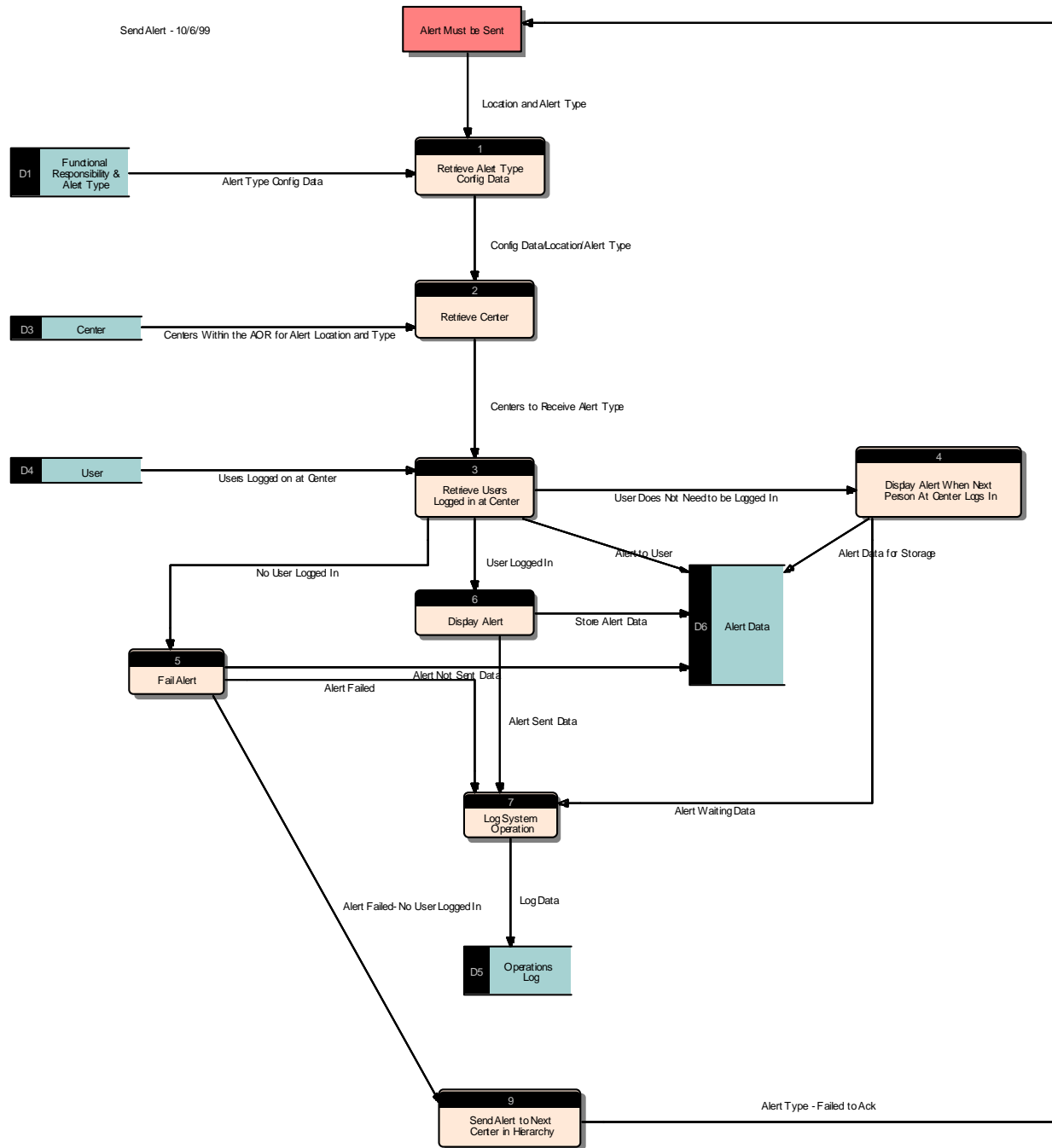
2.2.4.5.3 Escalate Alert

The Escalate Alert process monitors those sent alerts that require a response within a specified time frame. If no response is received, it accomplishes the necessary steps to escalate the alert up the operation center hierarchy. This process will capture date and time of the failed response, determine the next level of hierarchy and center with the appropriate alert type and area of responsibility, and send the alert to this center. Until the alert is responded to or escalated to the SOC, this process will continue to monitor and escalate the alert upwards through the center hierarchy.

This process will also be used to escalate alerts when no user is logged on at the receiving center.

Escalate Alert - 10/7/99
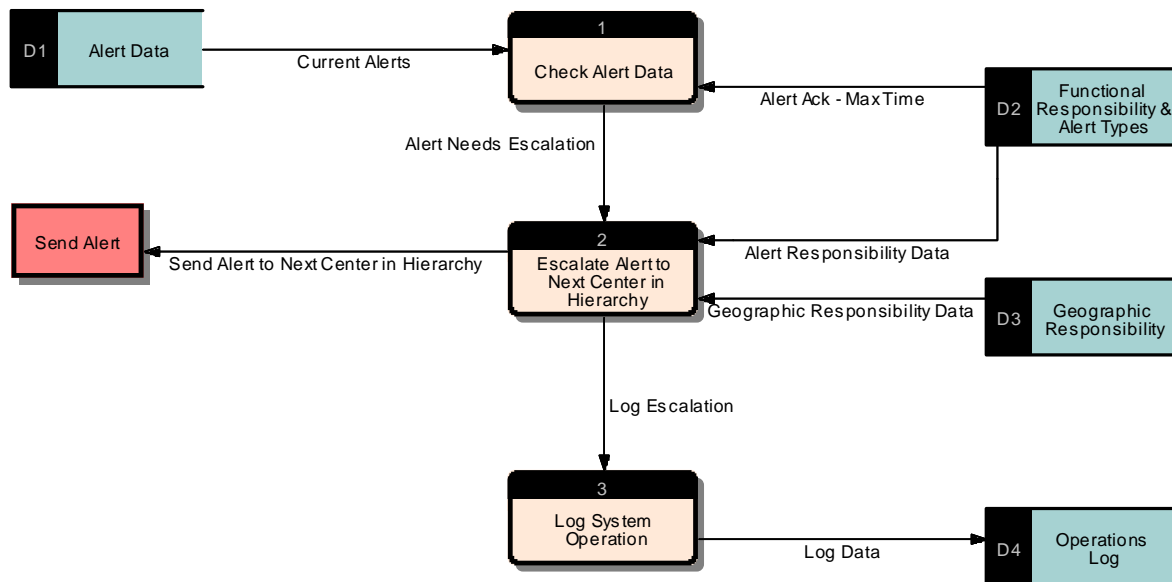
Figure 2-121. Escalate Alert

2.2.4.6 Plans

The Plans processes include all those processes necessary to define, setup and control the activities involved in handling plans. These processes are divided into groups related to maintaining and processing of plans.

Plans are *sets of commands* equivalent to functions that an operator might perform. A plan is comprised of a set of commands which, when the plan is activated, are executed in sequence. When a plan is deactivated, the converse of the individual commands is executed in sequence.

Plans - 9/8/99

```
┌─────────────────────────────┐
│ 1                         ▽ │
│          Plans              │
│                             │
│   ┌─────────────────────┐   │
│   │ 1.1                 │   │
│   │                     │   │
│   │   Maintain Plans    │   │
│   │                     │   │
│   └─────────────────────┘   │
│                             │
│                             │
│   ┌─────────────────────┐   │
│   │ 1.3                 │   │
│   │                     │   │
│   │   Activate Plan     │   │
│   │                     │   │
│   └─────────────────────┘   │
│                             │
│                             │
│   ┌─────────────────────┐   │
│   │ 1.2                 │   │
│   │                     │   │
│   │  De-Activate Plan   │   │
│   │                     │   │
│   └─────────────────────┘   │
│                             │
└─────────────────────────────┘
```

Figure 2-122. Plans

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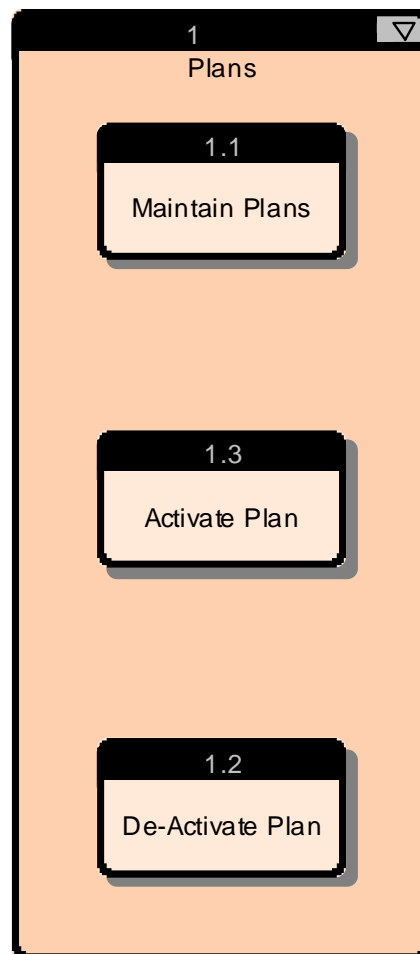
2.2.4.6.1 Maintain Plans

The Maintain Plans process provides for the establishment and maintenance of plans.

Plans may be used for such activities as displaying specified messages on DMS devices, broadcasting of specified messages on HAR devices, setting devices on/off line, setting AVCM presets, assigning cameras to wall monitor configurations, activating tours, plan activation/deactivation, notifications, and logging.

A single plan may define the control of multiple devices, which will all be initiated by activating the plan.
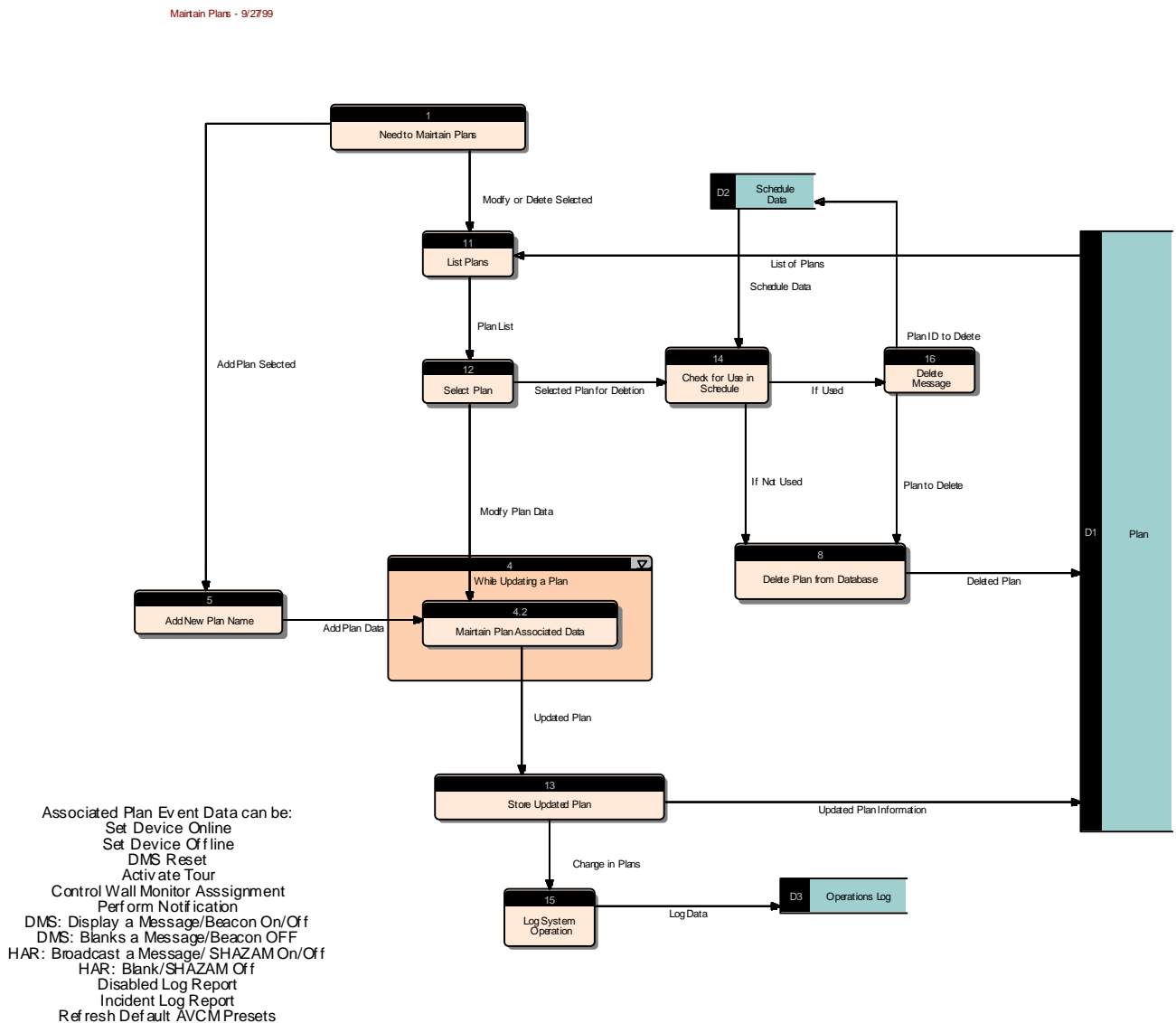
Figure 2-123. Maintain Plans

2.2.4.6.2 Activate Plan

The Activate Plan process may be initiated by an operator, as an item in a schedule, or as a response to a weather alert. If there is no log associated with the plan, this process initiates a log. The type of log is dependent on the type of plan and the function it performs. The stored commands are read from the plan and executed in sequence. Each command in the plan is executed by interfacing with its related process/application.
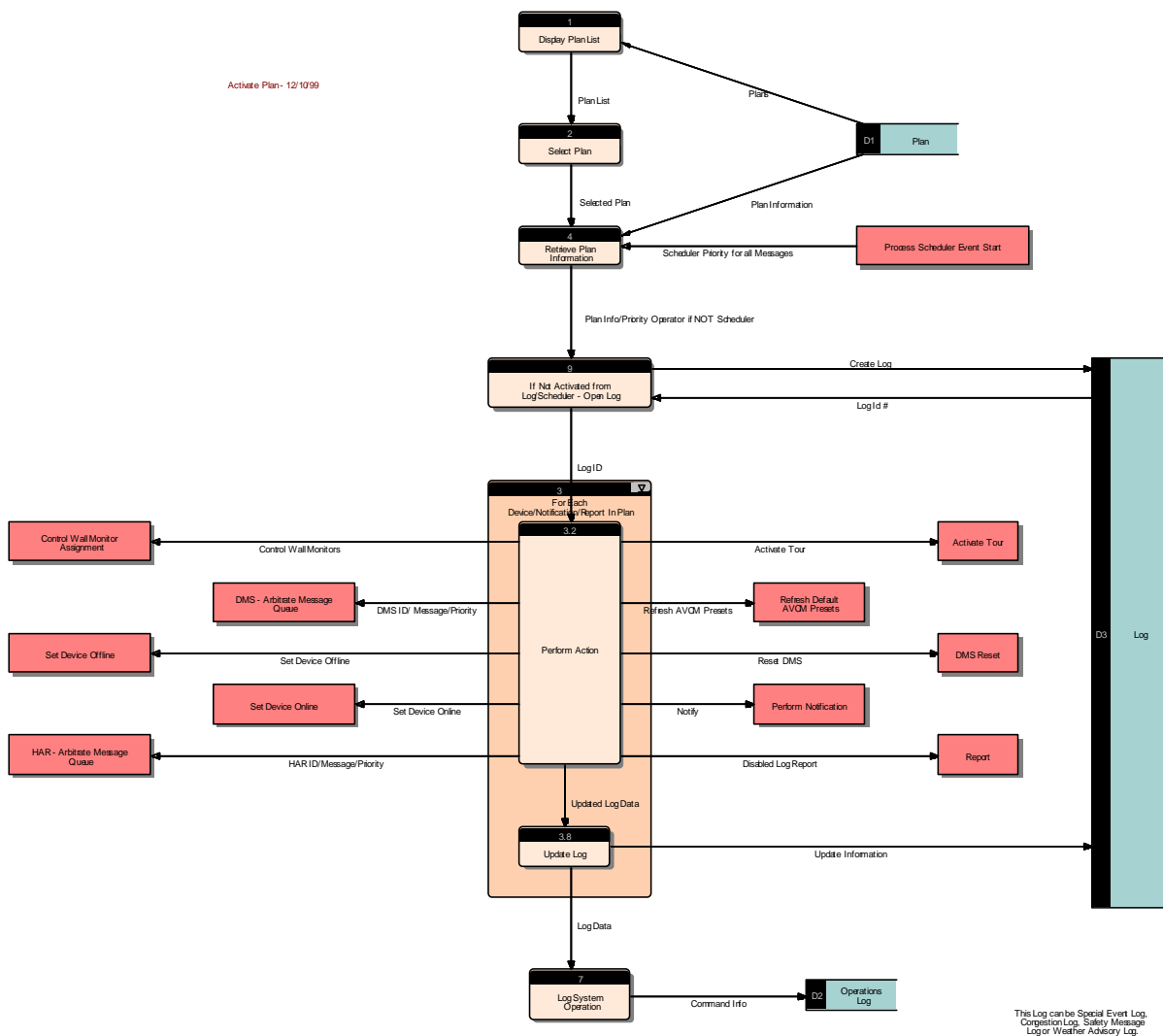

Figure 2-124. Activate Plan

2.2.4.6.3 Deactivate Plan

The Deactivate Plan process is activated by an operator or as an item in a schedule. The stored commands are read from the plan and processed in sequence. A determination is made as to the appropriate deactivation of the original command (*for example,* a DMS – Add A Message command will have a deactivation command of DMS – Remove A Message). Some original commands will logically have no deactivation command (*for example,* print a report command would have no deactivation command). Each deactivation command derived from the plan is executed by interfacing with the appropriate process or application. If, after all resources associated with the plan are released, there are no other resources associated with log, the user is asked whether the log should be closed. The log is then closed on confirmation.
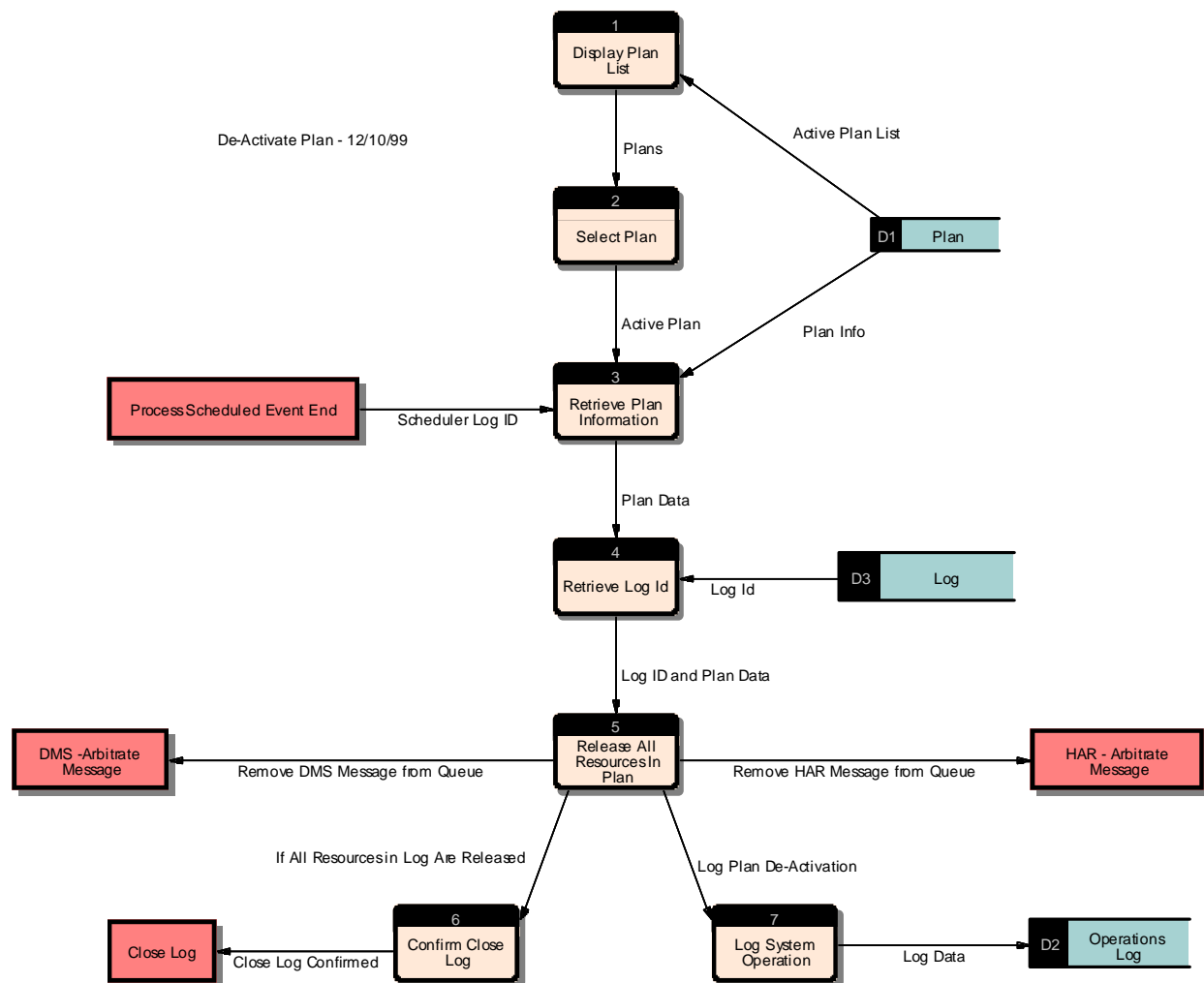
Figure 2-125. Deactivate Plan

2.2.4.7 Scheduled Events

The Scheduled Events processes include those processes necessary to define, setup and control the activities involved in handling scheduled events. These processes are divided into two individual processes related to maintaining and processing of scheduled events. The following figure identifies each group.

Scheduled Events - 11/16/99
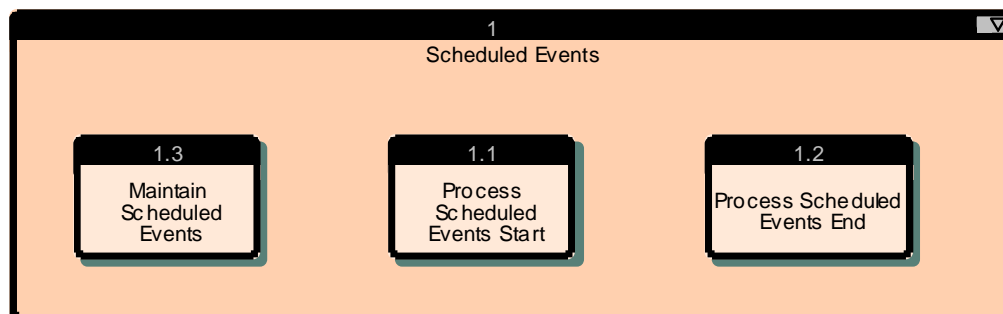
Figure 2-126. Scheduled Events

2.2.4.7.1 Maintain Scheduled Events

The Maintain Scheduled Events process is used to add, modify, or delete schedules and the activities involved in handling a scheduled event. Schedules include identification of the schedule and date/time stamps for starting and stopping the execution of the activities. Some of the activities to be executed within a schedule are; setting devices on/off line, DMS displays, HAR messages, AVCM presets, wall monitor configuration, tours, plan activation/deactivation, notifications, and reports. All activities within the schedule are executed in sequence at the start time of the schedule.

The system needs to be able to process scheduled events based on time of day, day of week, day of month, and also provide operator control to manually initiate and terminate any schedule.

The maintenance of scheduled events is a System Administrator process.

Each schedule will include the type of activity to which it's related so that a corresponding type of Activity Log may be generated to track the CHART activity. Schedule types will include Special Events, Recurring Congestion, and Safety Messages.

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9
Need to Maintain Scheduled Events

Add New Event | ModifyDelete

1
Select New
Scheduled Event
Name

2
List Scheduled
Events

Events

New Event | List

16
Determine Scheduled
Event Type

4
Select Scheduled
Event

DeleteEvent

8
DeleteScheduled
EventData

Deleted Data

List Data | Event to Modify

10
While Not Done

10.1
List Associated Data

Associated Data

New Data

List of Event Data

10.2
Select
Associated
Data

Data to Maintain

10.3
Maintain Associated Data

D1 | Scheduler
Data

Scheduler Date/Time Data

D2 | Operations Log

14
Check for Scheduler
Conflicts

Log Data

If No Conflicts

15
Log System
Operation

Updated Data

7
Store Scheduled Event Data

Scheduler Data

*** Associated Scheduler Event Data can be:
Set Device Online
Set Device Offline
DMS Reset
Activate Tour
Control Wall Monitor Assignment
Perform Notification
DMS: Display a Message/ Beacon On/Off
DMS: Blanks a Message/Beacon Off
HAR: Broadcast a Message/SHAZAM On/Off
HAR Blank/SHAZAM OFF
Disabled Log Report
Incident Log Report
Refresh Default AVCM Presets
Activate a Plan
De-Activate a Plan

Scheduled Event Type can be (First Draft List):
Special Events
- Orioles
- Ravens
- Concert
- Parade
Construction
Congestion
Administrative
- Reports
- EORS Upload

Figure 2-127. Maintain Scheduled Events

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2.2.4.7.2 Process Scheduled Events Start

The Process Scheduled Events process is a custodial process. The system will open a log (based on type of scheduler event – recurring congestion, special event, or safety message) and begin executing the activities of the schedule according to the date/time stamp of the schedule information. Each activity is processed in sequence. Each activity in the schedule is executed by interfacing with its related process/application.

CHART II Business Area Architecture Report   224   August 23, 2000
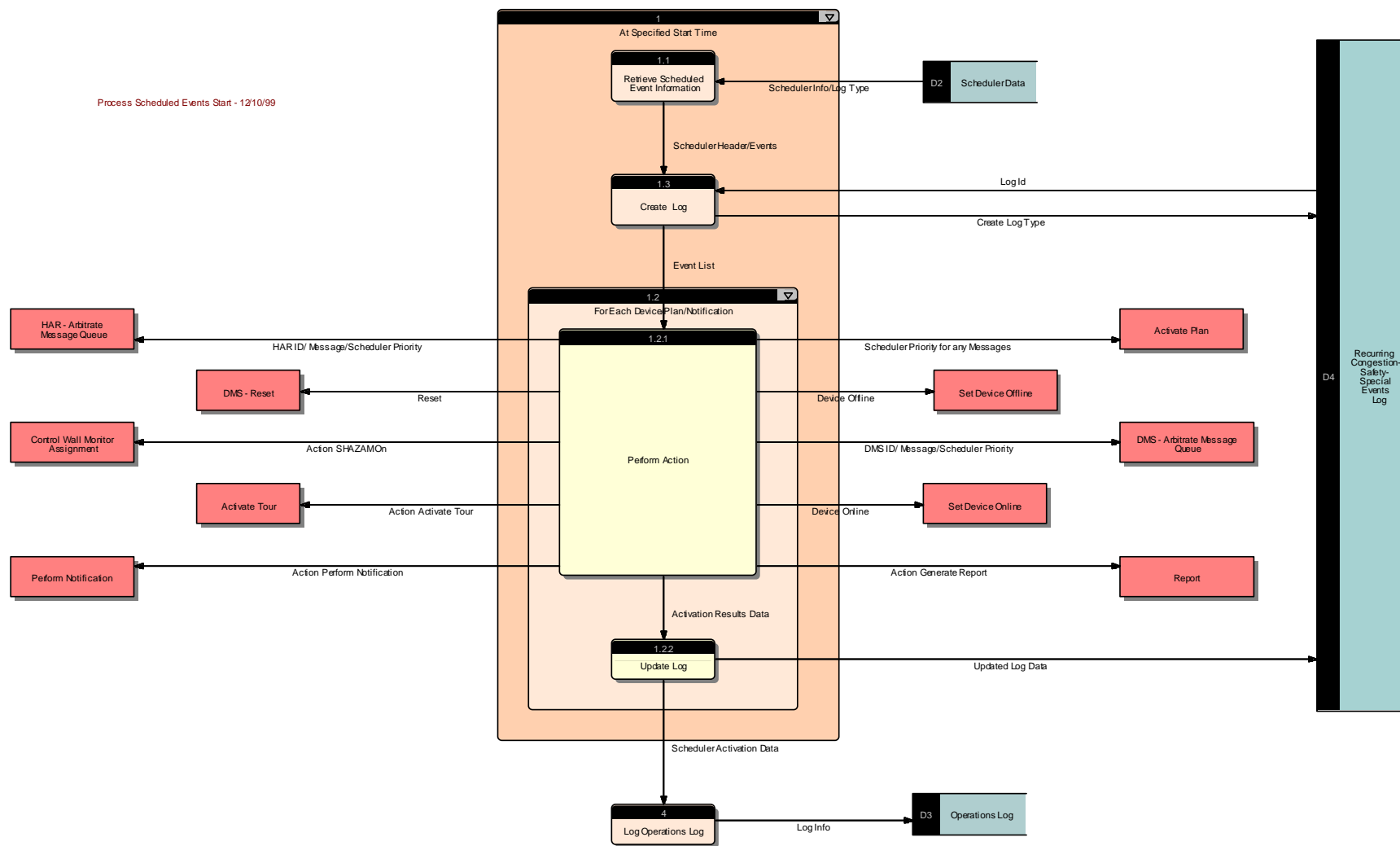
Figure 2-128. Process Scheduled Events Start

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2.2.4.7.3 Process Scheduled Events End

The Process Scheduled Events End process retrieves the Log ID of the associated log and calls the Close Log process to release all shared resources. If the scheduled event will not be repeated, it is deleted from the system.
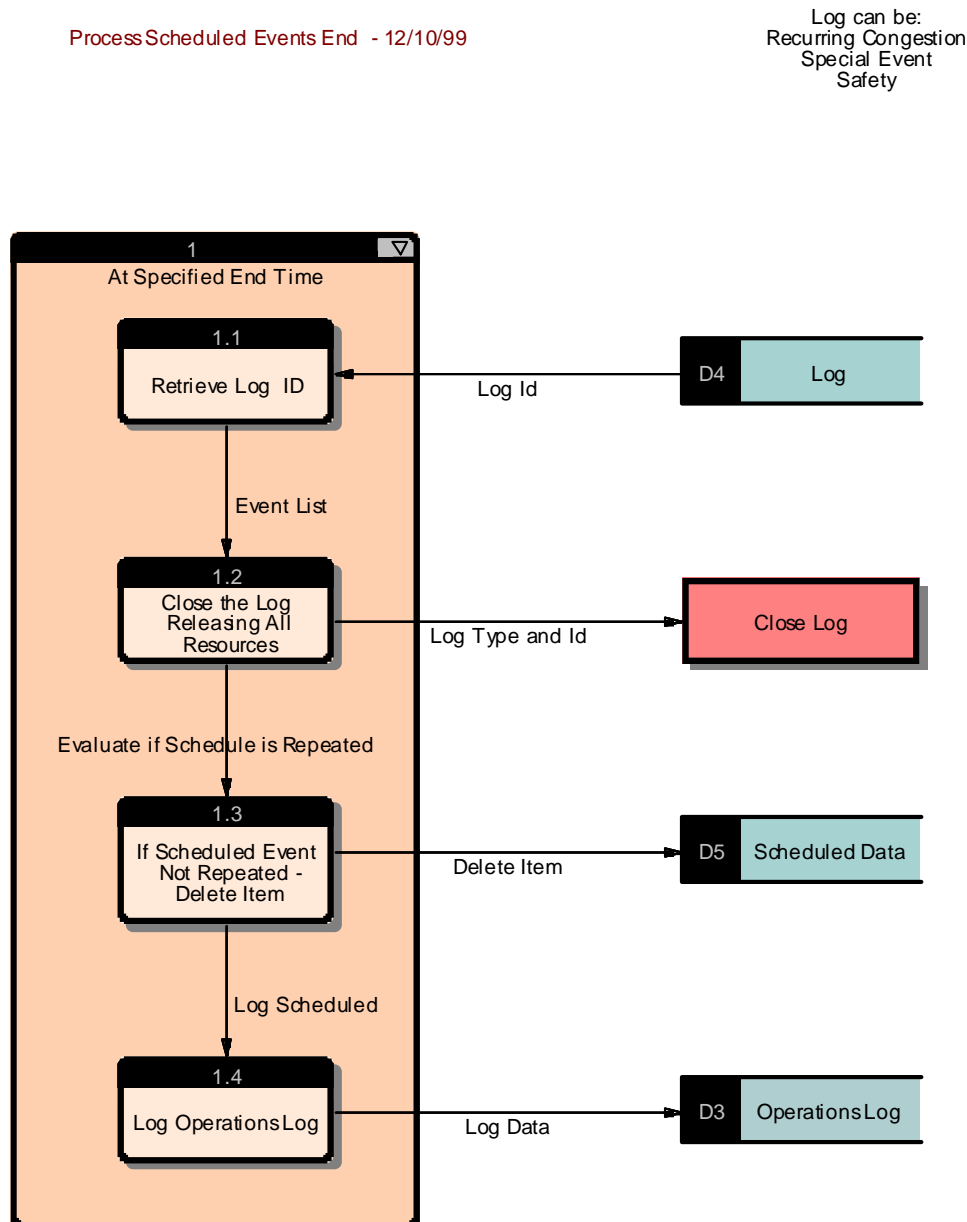
Figure 2-129. Process Scheduled Events End

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2.2.4.8 EORS Interface

The EORS Interface processes include all those processes necessary to identify and process road construction-related closures and tracking of declared snow emergencies at the county level. The following figure identifies the individual processes within each group.

EORS Interface - 10/7/99
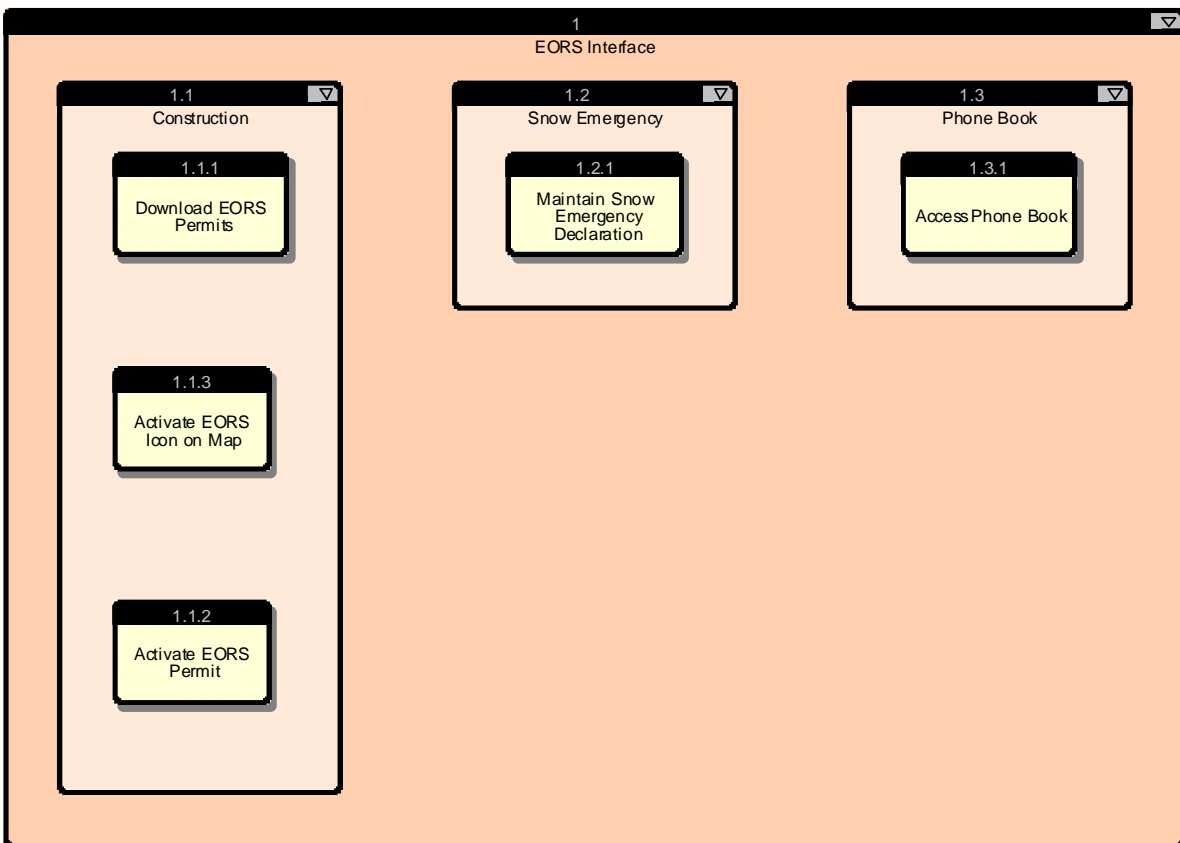
Figure 2-130. EORS Interface

2.2.4.8.1 Construction

The Construction group of processes identifies how road construction requests are received into the system (Download EORS Permits), how the EORS permits are displayed (Activate EORS Icons on Map), and how the permits are activated (Activate EORS Permit) as Incidents.

2.2.4.8.1.1 Download EORS Permits

The Download EORS Permits process is used to download information on planned road construction-related closures from the EORS system. The information from EORS is two-tiered with permit information on the first tier and schedule information associated to the permit on the second tier. This is a custodial process, which, at a parameter specified time interval, retrieves the EORS information for a parameter specified time period and stores the permit and schedule information in the CHART system. The primary intent of this process is to download the permits for the next day or two so they can be available on CHART before the road closures take place. The process also determines if there is a conflict with a special event item scheduled during the same time frame and stores conflict data with the permit data.

Download EORS Permits -11/10/99
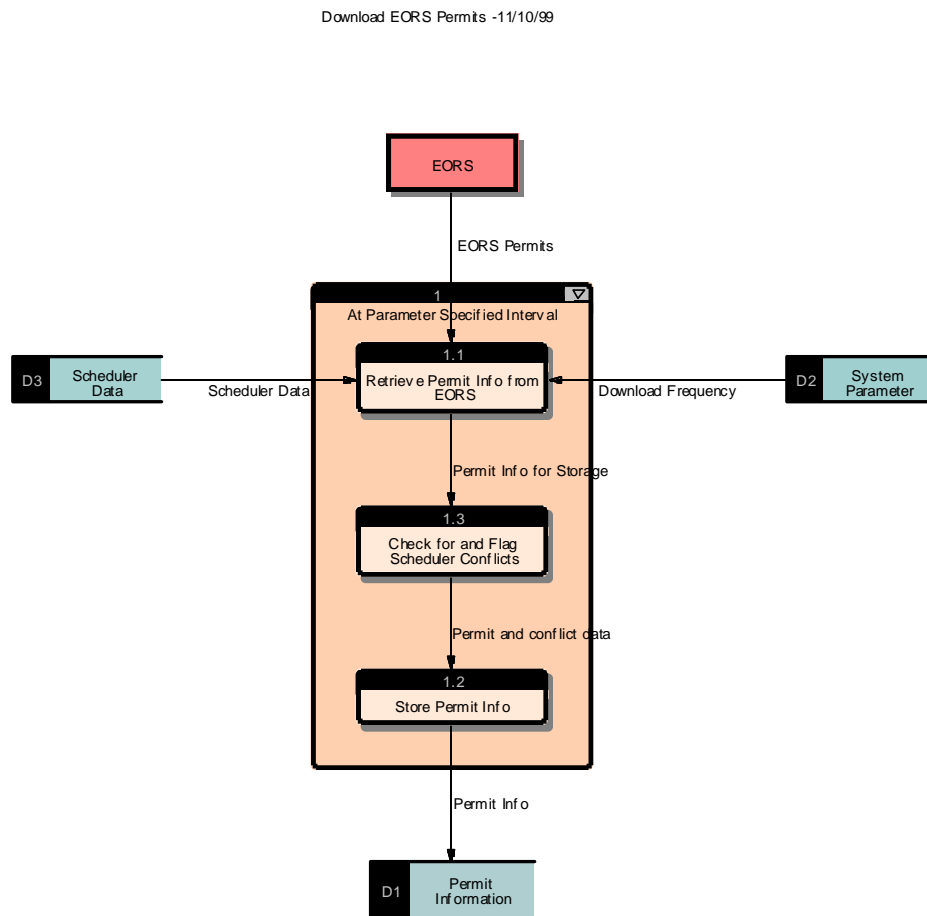
Figure 2-131. Download EORS Permits

2.2.4.8.1.2 Activate EORS Icons on Map

The Activate EORS Icons on Map process is a custodial process in which the system periodically analyzes the downloaded EORS permit information. For those permits scheduled to start within a parameter specified time period, it generates map icons for these permits in preparation for the Activate EORS Permit process.

Activate EORS Icon on Map - 9/17/99
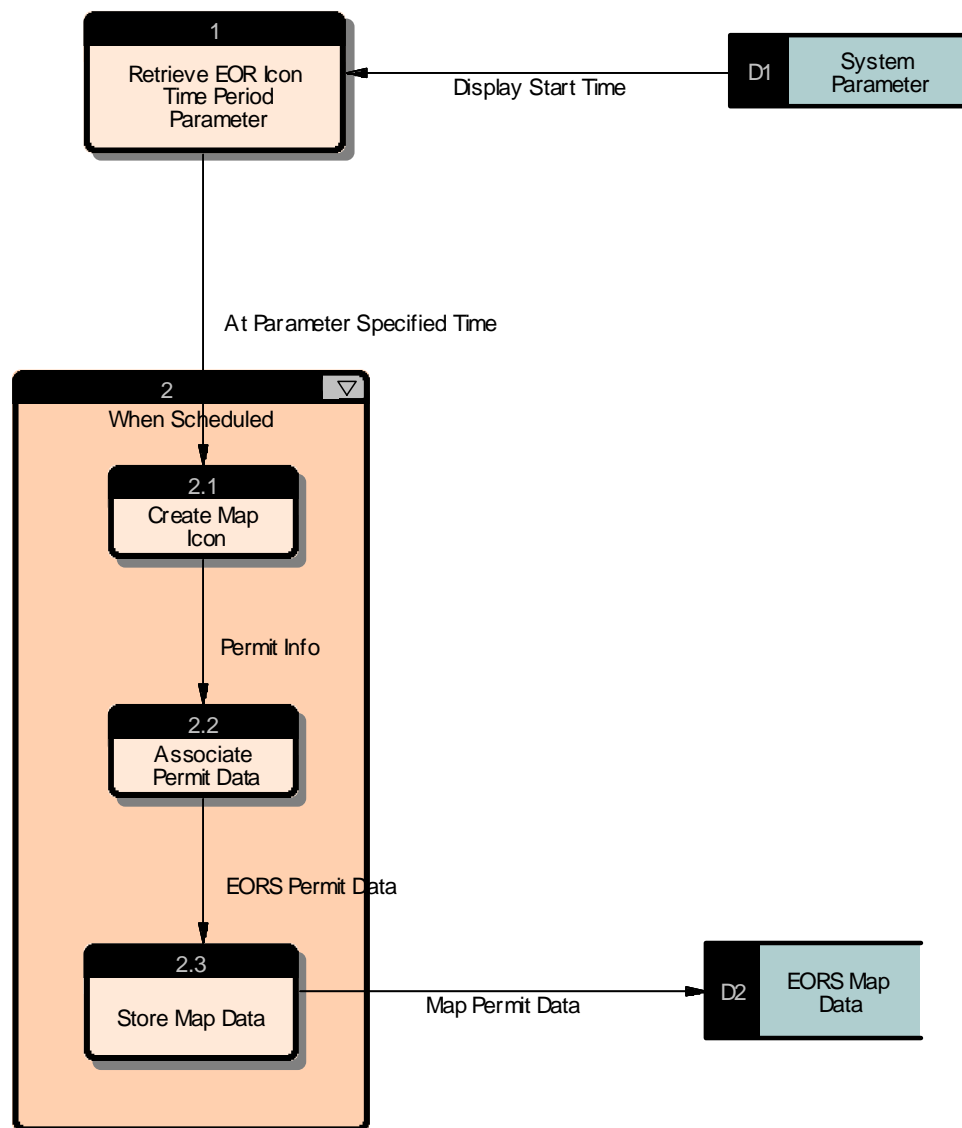
Figure 2-132. Activate EORS Icons on Map

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2.2.4.8.1.3 Activate EORS Permit

The Activate EORS Permit process provides the capabilities for operators to initiate Incident Logs related to lane closure(s) due to road construction. Operators receive phone calls from the construction crews advising them that one or more lanes will be blocked and providing the permit information relative to this closure. The operator selects the relative EORS permit icon and indicates the start time and specific lanes for the closure. The system checks the current status of the location of the intended closure and notifies the operator of any planned special events and current incidents or congestion. The operator may deny activation of the permit based on this information. If the operator determines conditions are acceptable for permit activation, the system generates an Incident Log and performs the usual Log Incident Log process steps. Information is sent to the EORS system to indicate activation of the permit/schedule item.

From this point the operator may decide to either transfer the responsibility for this incident to another center or manage the incident from his/her center.

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1
Receive EORS
Permit Activation
Notification

Activate EOR Permit -12/6/99

Lane Level location info

7
Check for
Incident/Activity
Conflict

D5 Special Event Log

Special Event Data

D4 Congestion Log

Congestion Location Data

Incident Location Data

D3 Incident Log

Conflict

No Conflict

8
Operator Evaluation

Conflict - Operator Override

2
Select Permit on Map

Incident Log ID

Lane-level Construction Info

Log Incident Log

Conflict - Cancel Permit

Permit Activation Info

9
Activation Not Allowed

6
Check Permit Start Time

Permit Conflict Data

Permit Start Time

If After Start Time

3
Store Permit Activation Info

Permit Info

D1 EORS Permit Information

Activation Info

EORS

Permit Data

Display Info

Log Operator Action

5
Log System Operation

If Not Reponsible Center

Transfer Resources

4
Display Active Permit on Map

Log Data

D2 Operations Log

Figure 2-133. Activate EOR Permit

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2.2.4.8.2   Snow Emergency

The Snow Emergency process group identifies county-level snow emergency declarations and provides a visual display of the declared/not declared counties. This information is provided to the operators to assist in wintertime traffic management.

2.2.4.8.2.1   Maintain Snow Emergency Declaration

The Maintain Snow Emergency Declaration process is a custodial process that periodically interrogates information in the EORS system related to county snow emergency declarations. When it is determined that a county has declared a snow emergency, a county-based snow emergency map layer is updated, a response plan is activated, and specified individuals and organizations are notified. As snow emergencies are canceled, the map layer is updated and the Weather Advisory Log is closed.

CHART II Business Area Architecture Report   232   August 23, 2000
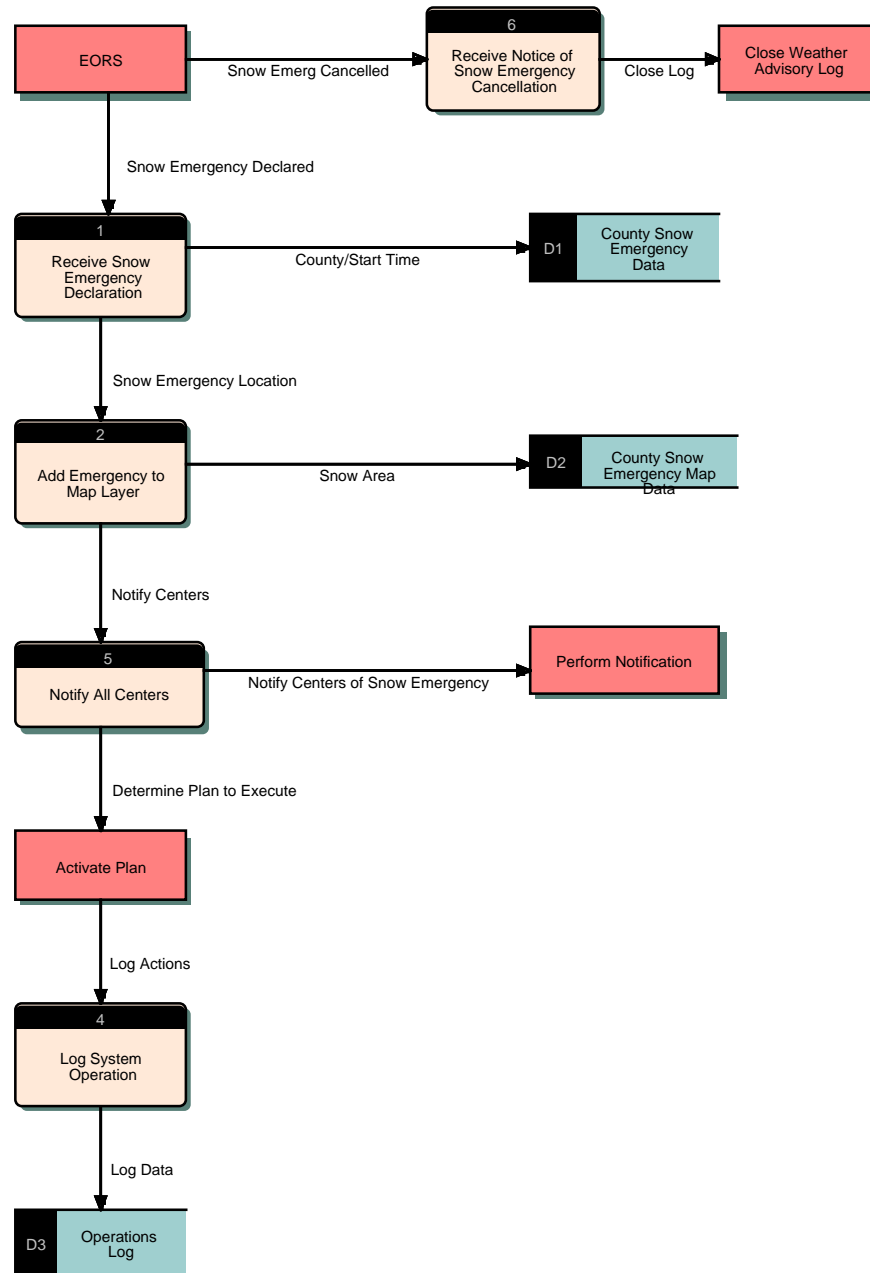
Figure 2-134. Maintain Snow Emergency Declaration

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2.2.4.8.3   Phone Book

The Phone Book group consists of a single process: Access Phone Book.

2.2.4.8.3.1   Access Phone Book

The Access Phone Book process is a way for CHART operators to view the CHART Phone Book being maintained under the EORS application. No process flow is shown for this process. The CHART system must provide a front-end access point to the Phone Book application built into EORS.

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2.2.4.9 Weather Support

The Weather Support processes include all those processes necessary to define how National Weather Service alerts and hazardous driving conditions will be detected and communicated. These processes are divided into groups related to National Weather Service and SCAN. The following figure identifies the individual processes within each group.
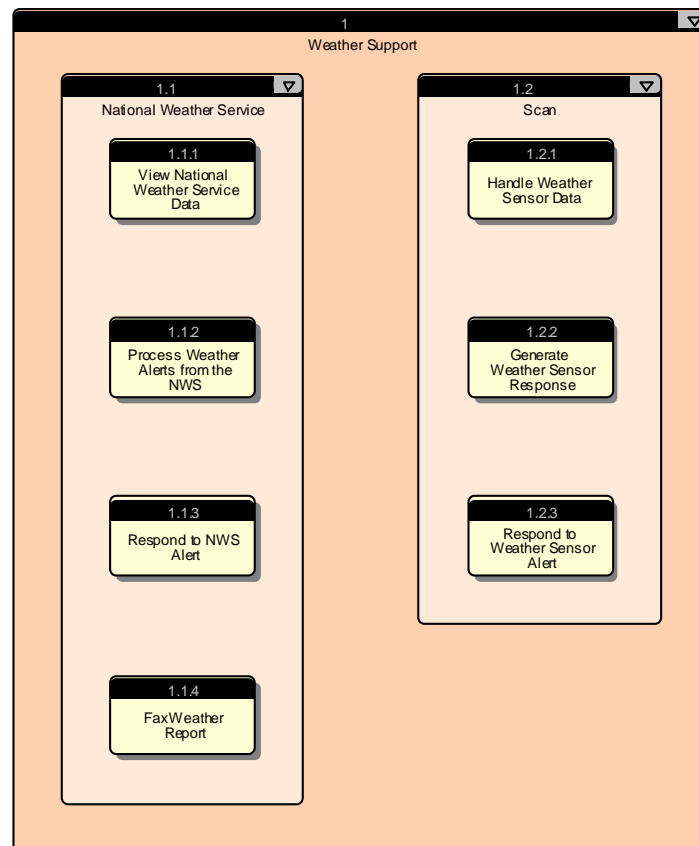
Figure 2-135. Weather Support

2.2.4.9.1 National Weather Service

The National Weather Service (NWS) group of processes identifies how National Weather Service data is viewed (View National Weather Service Data), how alerts from the National Weather Service will be handled (Process Weather Alerts from the National Weather Service), and how notifications are made (Fax Weather Report).

2.2.4.9.1.1 View National Weather Service Data

The View National Weather Service Data process provides operators with the capability to view National Weather Service data stored on the SHA Web pages. From the CHART navigator, operators can select the specific NWS weather data/web page they need to view. If the browser has not been opened, the browser on the selected page will be opened. If the browser is already open, the selected page will be displayed in a new window/page *over* the current one on the browser (rather than opening a new browser). This is done to keep the memory requirements minimized for the workstation, as well as, keeping clutter off the operator's display.
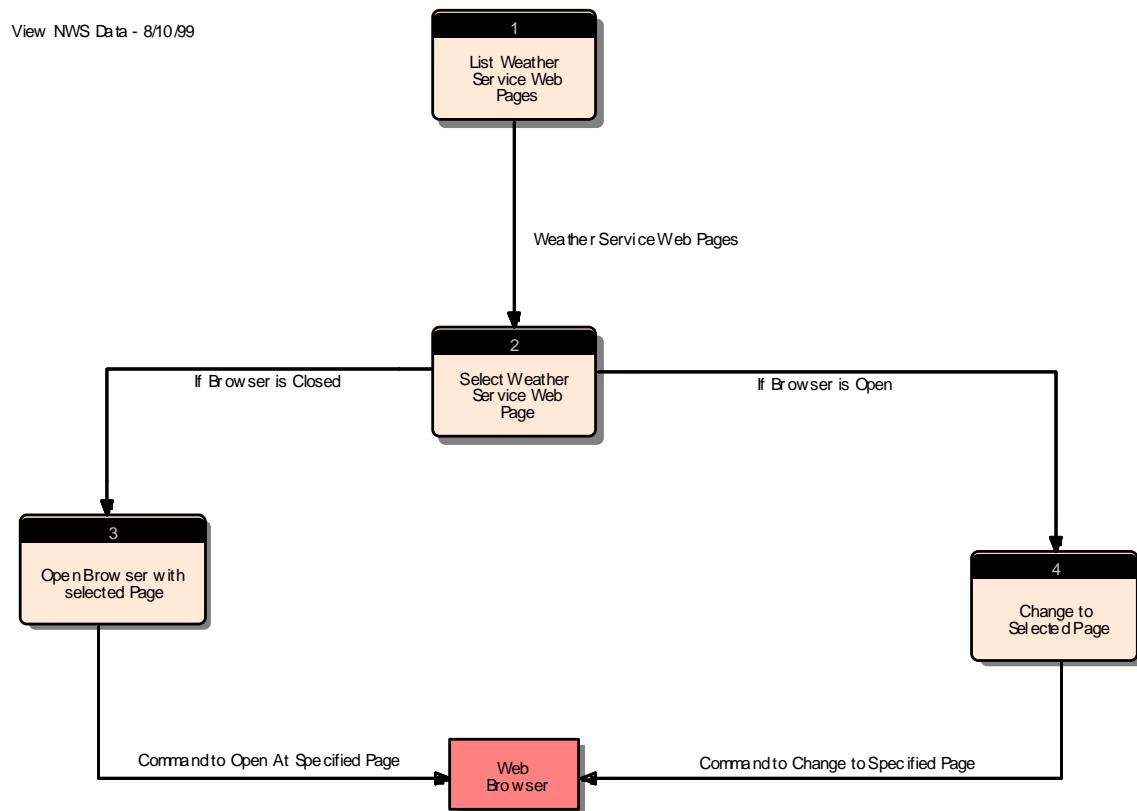
Figure 2-136. View National Weather Service Data

2.2.4.9.1.2 Process Weather Alerts from the National Weather Service

The Process Weather Alerts from The National Weather Service process is used to detect and alert operators if the National Weather Service has issued/updated any severe weather alerts. This is a custodial process that checks the file size of NWS alert file on the SHA Web server. If the file size is greater than a specified size a weather alert is sent to all users with the exception of the media.

ProcessNWS Alert - 10/26/99
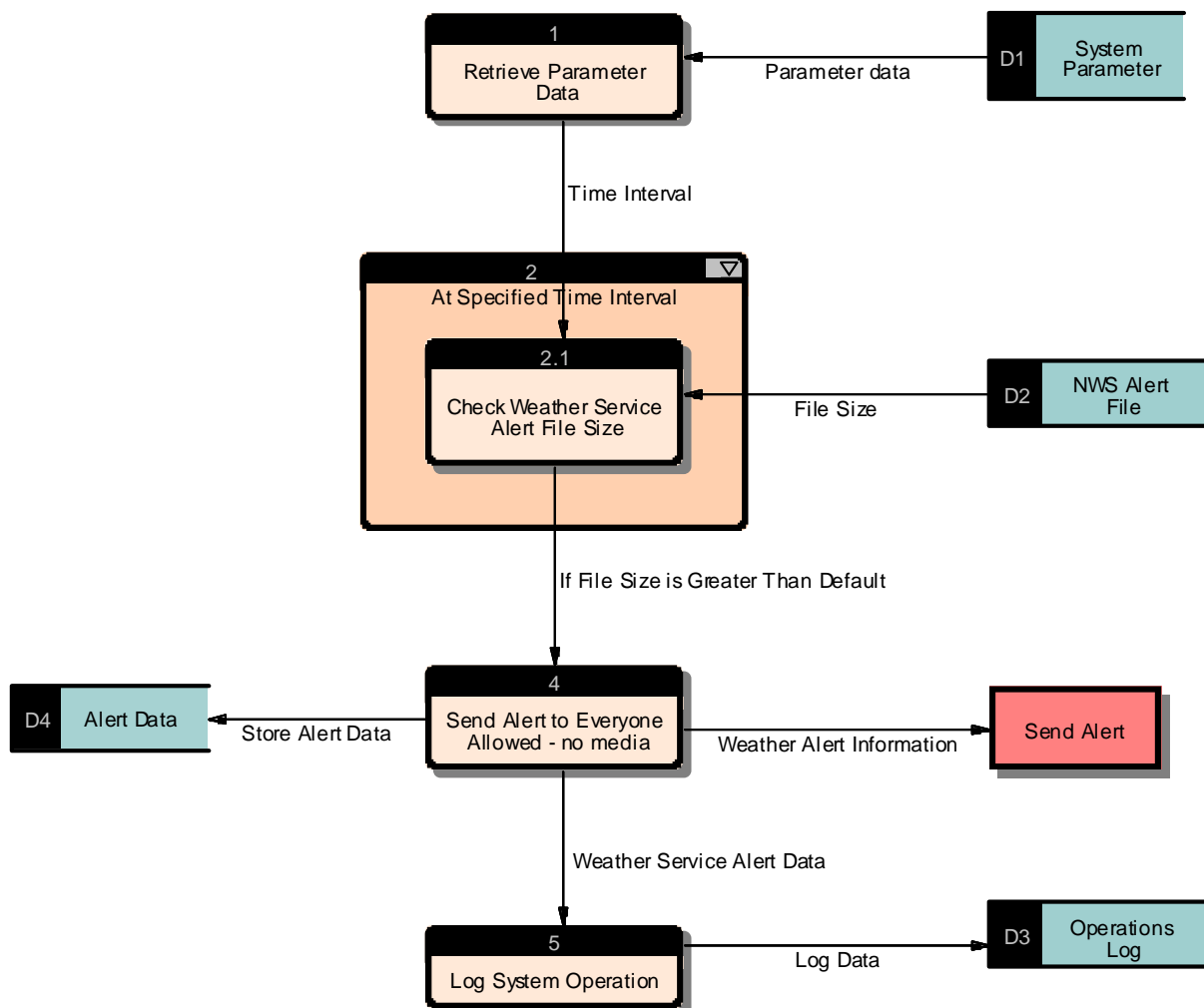
Figure 2-137. Process Weather Alerts from National Weather Service

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2.2.4.9.1.3 Respond to National Weather Service Alert

The Respond to Weather Alert process is used to allow the individual being sent the Weather Alert to acknowledge it. When the alert is acknowledged, the date and time is captured, and the weather alert is displayed.

10/6/99
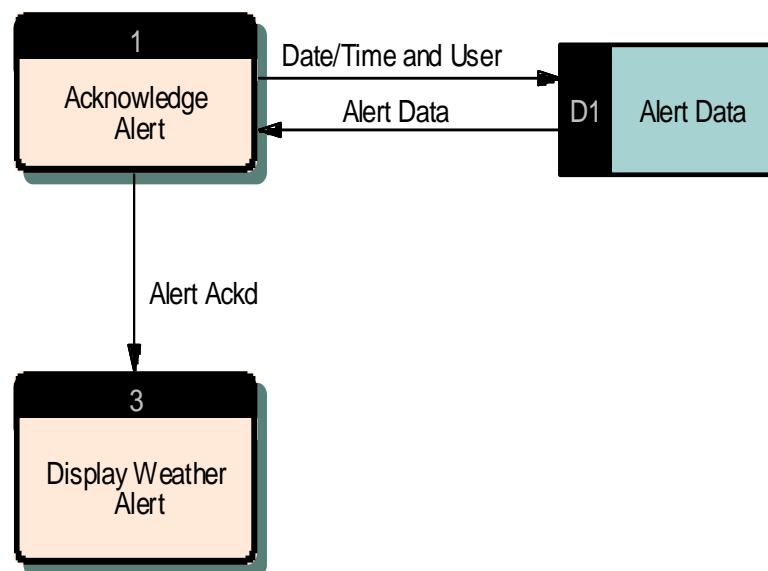
Figure 2-138. Respond to National Weather Service Alert

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2.2.4.9.1.4 Fax Weather Report

The Fax Weather Report process will periodically distribute weather reports via fax to specified recipients. The weather report is retrieved from the SHA Web server at a system parameter-specified frequency. A fax is then formatted and sent to recipients identified in the Notification List.
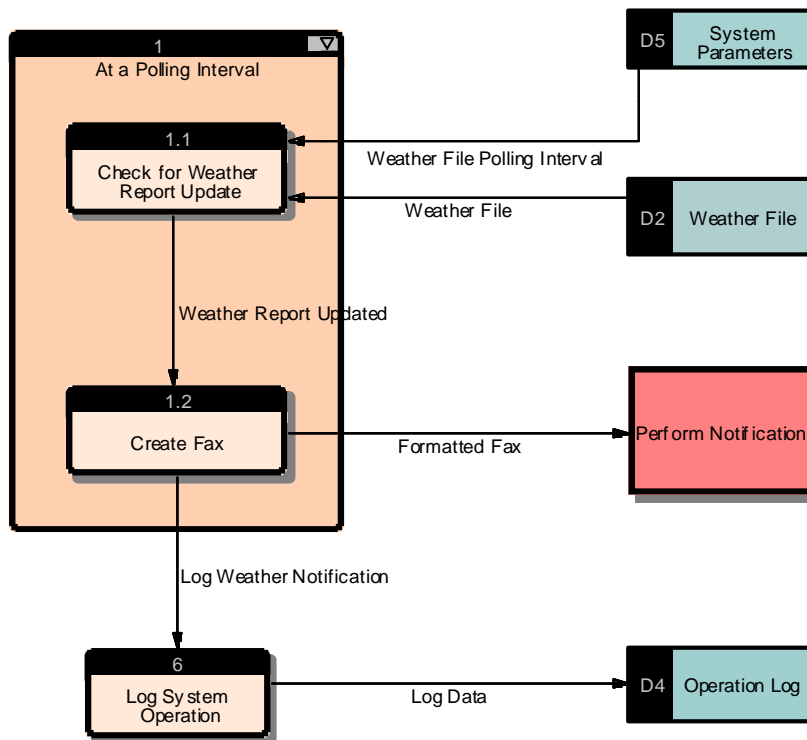
Figure 2-139. Fax Weather Report

2.2.4.9.2   SCAN

The SCAN group process is used to handle sensor information captured from specific locations along the roadways and to provide traveler information based on deteriorating conditions.

2.2.4.9.2.1   Handle Weather Sensor Data

The Handle Weather Sensor Data process is used to process information received from the SCAN database and to enable the information to be communicated via the CHART system. The CHART system polls the SCAN database and, if there is no device failures reported, the CHART system stores and evaluates the information received. Weather sensor data received from SCAN is updated to CHART to show the current device status. Weather and road condition data is analyzed against device specific thresholds to determine if conditions necessitate notification of poor weather or roadway conditions. If poor conditions exist, processing will continue to the Generate Weather Sensor Response process.

This process assumes an interface with the SCAN database to obtain weather sensor status and data. These sensors are polled on a low frequency basis possibly due to the current communications architecture between the SCAN server and sensors (long distance dial-up). Should the frequency of polling need to be significantly increased, analysis of alternative communication options could be reviewed with an eye towards an FMS/PBX type interface that might provide a cost trade-off to be considered; lower communications versus FMS/PBX development and implementation costs.

CHART II Business Area Architecture Report   240   August 23, 2000
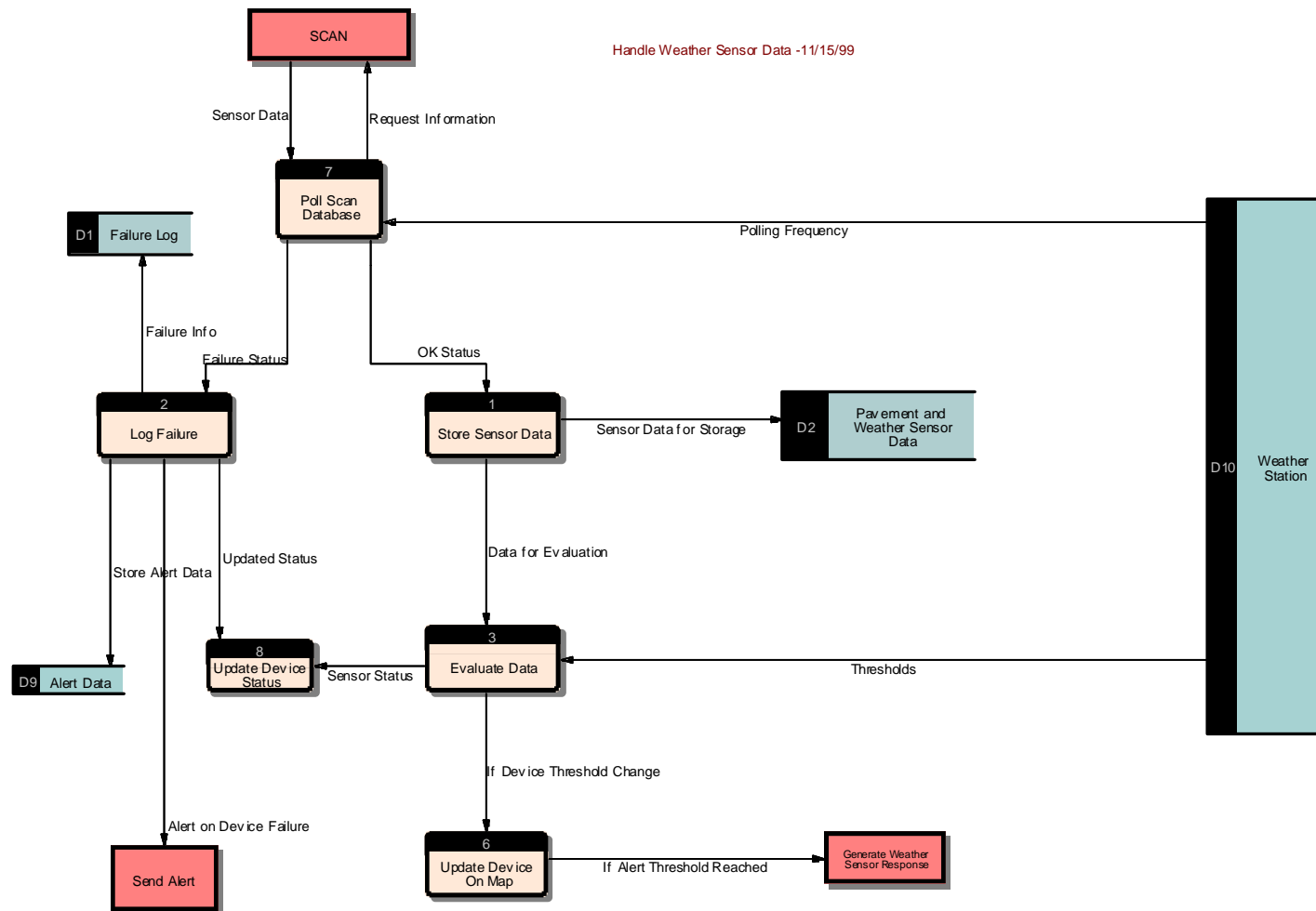
Figure 2-140. Handle Weather Sensor Data

2.2.4.9.2.2 Generate Weather Sensor Response

When the evaluation of weather sensor data in Handle Weather Sensor Data shows a change to hazardous weather or roadway conditions, the system generates a weather sensor response plan to notify travelers of the potential danger. Messages that are for DMS and HAR devices are retrieved from a plan associated with the specific weather sensor, or created from pre-defined message generation rules. Any required notification is sent to the proper recipients and, if also required, an alert is sent.

There is a need to be able to provide different response schemes for different weather or roadway conditions, *for example:* wind, fog, frozen pavement, etc.

This process assumes that a response plan may be a combination of an existing plan and rules-based responses.

Based on system parameters, an alert may be sent to the responsible operation center to request activation of the response plan, or to notify the responsible center of the activation of the response plan.
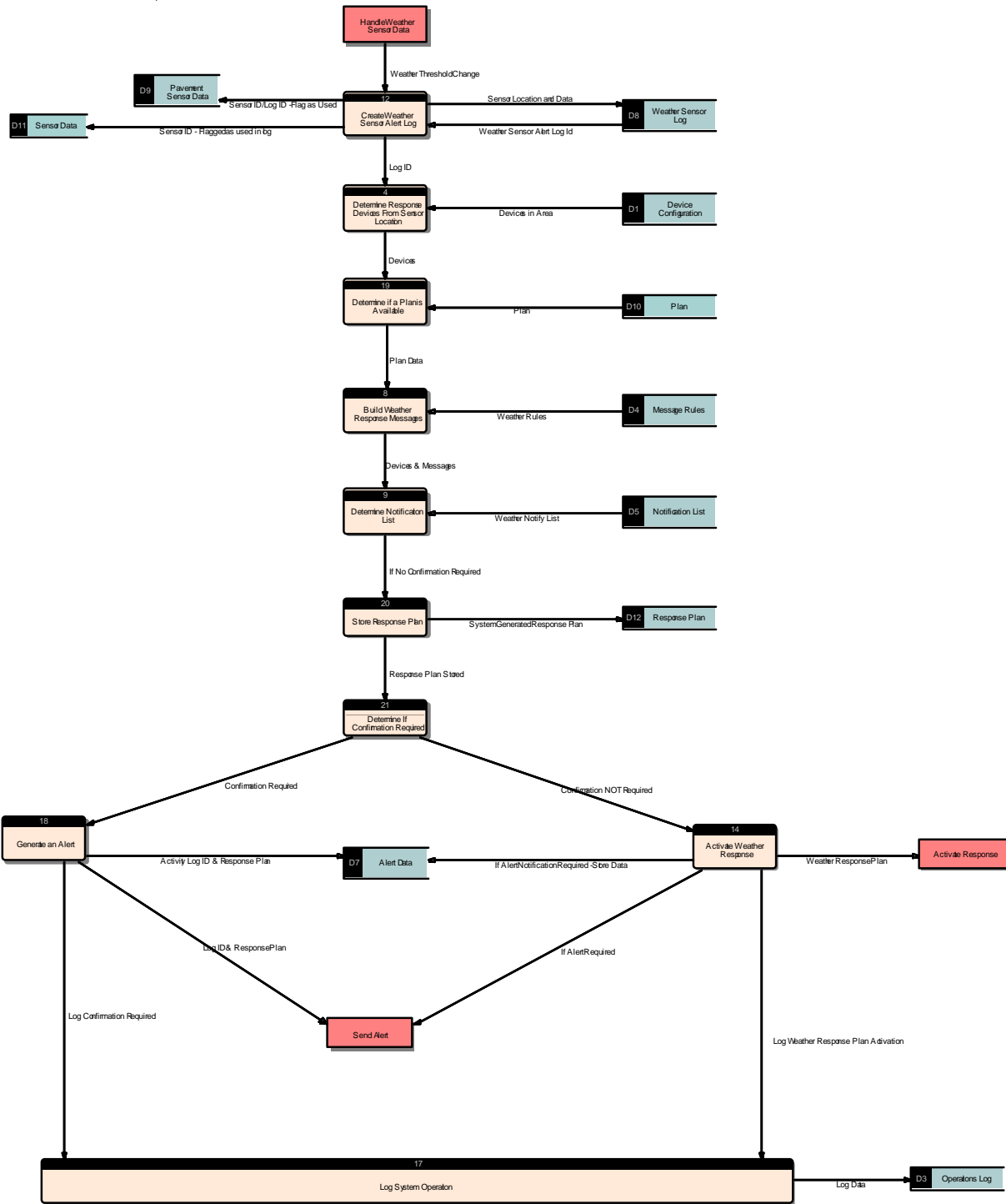
Figure 2-120. Generate Weather Sensor Response

2.2.4.9.2.3 Respond to Weather Sensor Alert

If confirmation of a weather sensor response plan is required, an alert is sent to the operator(s) at the center responsible for the sensor that triggered this process. Once a user acknowledges the alert, a Weather Sensor Alert log is displayed with the location of the sensor, time of detection, the system generated response plan, and any other information. The operator may then activate the response plan or cancel the plan. If the plan is cancelled, the operator is allowed to flag the weather sensor for a user-determined period of time so future evaluation would not trigger the generation of another response plan. While the Weather Sensor Alert Log is open, the triggering sensor device will generate no new alerts. Once the sensor returns values within normal parameters the log is closed.

The system may also be configured to alert the operator that a weather sensor response plan has gone into effect.
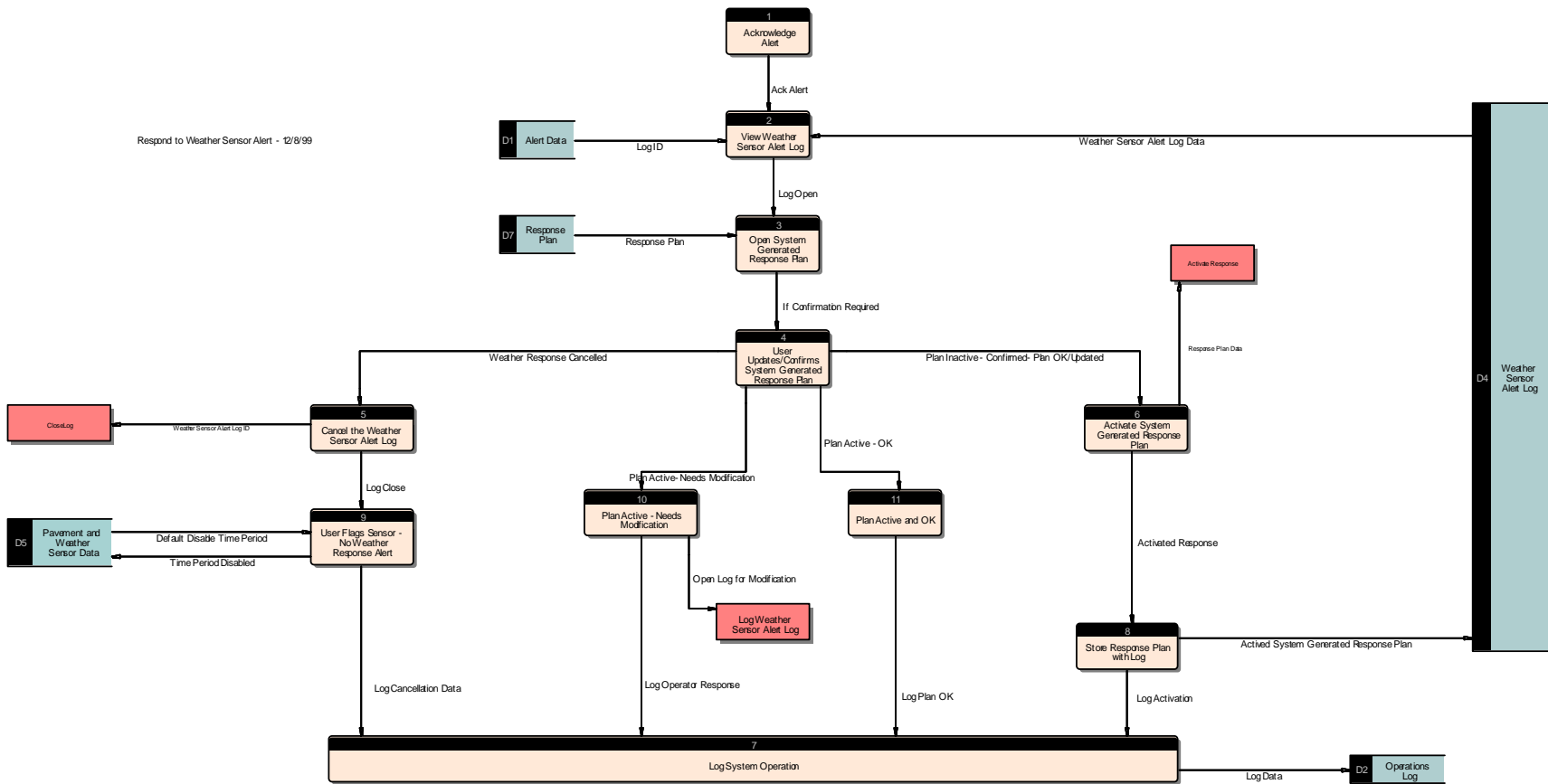
Figure 2-141. Respond to Weather Sensor Alert

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2.2.4.10 Archiving and Reports

The Archiving and Reports process group is separated into two groups: Archiving processes and Report processes.

Archiving and Reports - 12/15/99
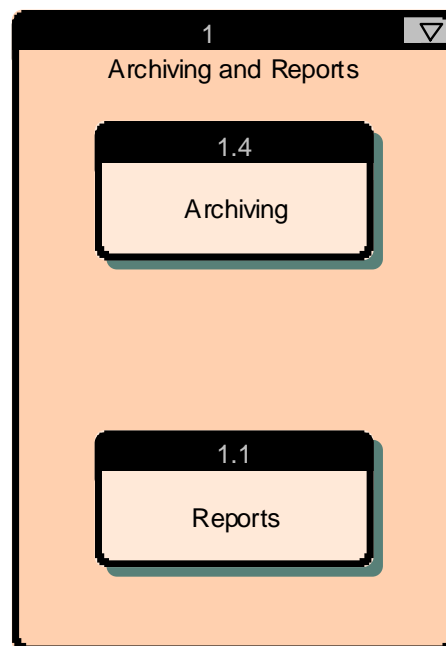
Figure 2-142. Archiving and Reports

2.2.4.10.1 Archiving

Archiving is a function that allows large amounts of information to be stored for later purposes. The primary uses of archived information are:

- Information will be available for other Maryland state agencies,

- Information will be used for CHART II simulation,

- Information will be available for legal purposes, and

- Information will be used for generating various reports.

CHART II is intended to maintain a 14-day operational set of data for use by the online operational parts of the system. At the end of each day, the current day's data will be copied or

added to the Archive data set, so that the Archive data should never have more than a 24-hour lag in data. It is also intended that log data will be both added and updated to the Archive data set. This implies that open logs may exist in the Archive data set, which may be updated as a result of the next day's processing in the operational system, and then be updated the following day in the Archive.

To maintain the 14-day operational data set, the oldest day's data need to be deleted from the operational data set each day after the Archive data is processed. An exception to this is open logs, in that they must remain on the operational data set until they are closed and reflected in the Archive. The following diagram illustrates the concept for adding/updating to the Archive and maintaining 14 days worth of data in the Operational database.
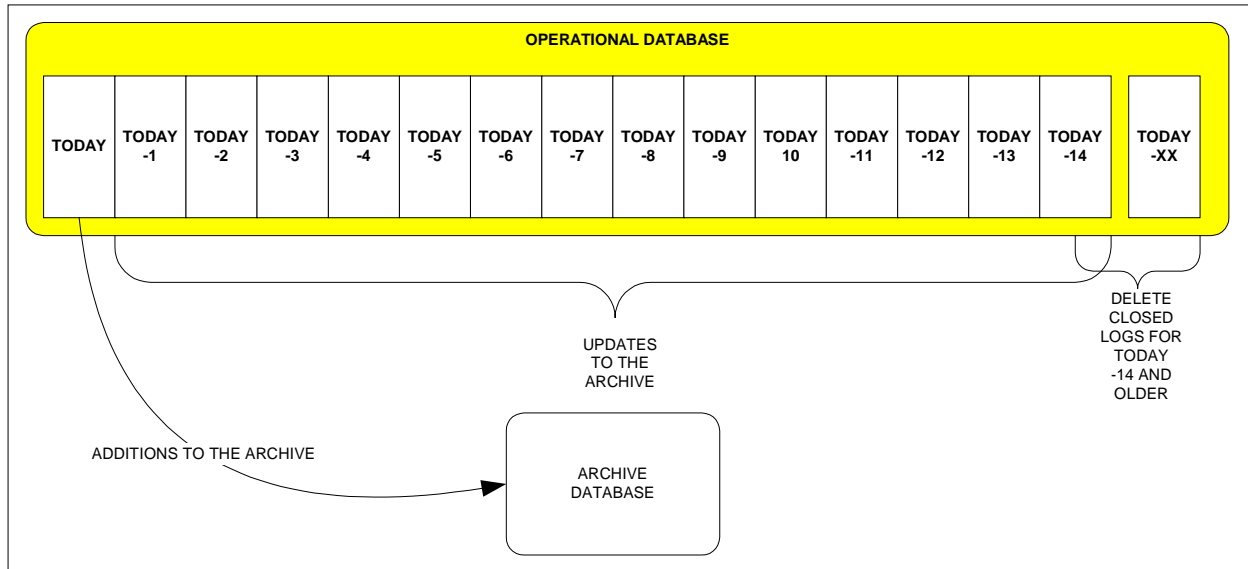
In order to understand the Archive, it is most important to understand what data will be kept in the Archive. The table below shows the data types of the CHART II system, and identifies which data types are/are not planned to be stored in the Archive.

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Data Type	Archive
Address Book	No
Alert Data	Yes
AVCM (Video)	No
AVL	Yes
Center	Yes
CHART Map Data	Yes
County Snow Emergency Data	Yes
Detector	Yes
Device Status	Yes
Dictionary	No
DMS	Yes
EORS Data	No
Equipment Data	Yes
Failure Log	Yes
HAR	Yes
Incident Interchange Database	Yes
Link	Yes
Location Navigation Information	No
Logs	Yes
Message Rules	No
Operations Log	Yes
Plan	Yes
Scheduler Data	Yes
Sensor Data	Yes
System Parameter	Yes
User	Yes

The concept for capturing Archive data is to perform a daily add/update from the operational database to the archive database. The table below shows which data types will be added, updated, or both.

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Data Type	Add /Update
Alert Data	Add
AVL	Add
Center	Add
CHART Map Data	Add
County Snow Emergency Data	Add
Detector	Add
Device Status	Add
DMS	Add
Equipment Data	Add
Failure Log	Add
HAR	Add
Incident Interchange Database	Add
Link	Add
Logs	Add/Update
Operations Log	Add
Plan	Add
Scheduler Data	Add
Sensor Data	Add
System Parameter	Add
User	Add

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2.2.4.10.1.1 Archive Update – Add

The Archive Update-Add process is a custodial process. The operational database will contain 14 days of operational data. Each day begins with 14 days of data. At a pre-determined time, the current day's information (Day 15) will be copied to the archive, unless in the case of Logs, the log is still open. The flow pictured below shows the addition of Day 15 operational data to the archive.

Archive Update Additions -
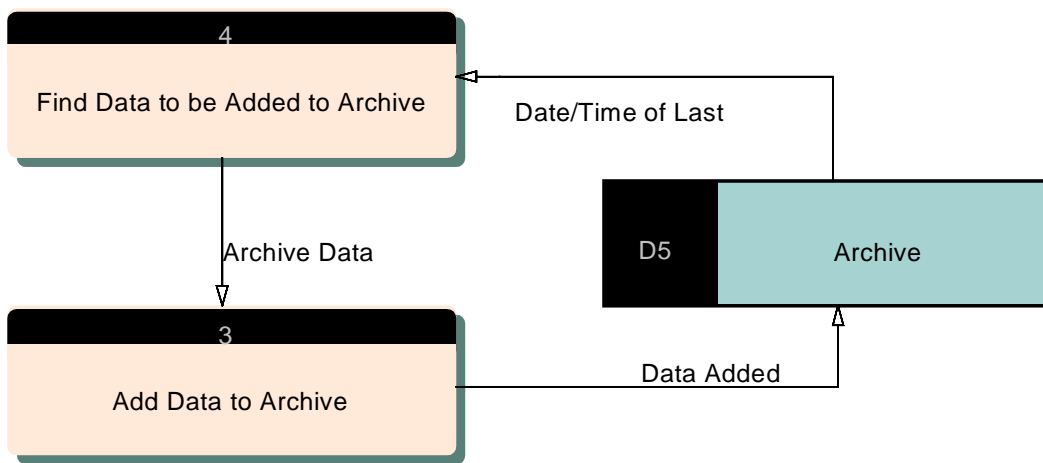
Figure 2-143. Archive Update - Add

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2.2.4.10.1.2 Archive Update – Update Log Data

The Archive Update-Update Log Data process is a custodial process. In the case of logs that remain open, instead of the information being copied, the information will be updated to reflect the most current information. This is to reflect any changes in the logs that have been made since the last data transfer. To see which data types will be updated – as opposed to only copied – see the table above.

Before any data from the logs can be transferred, the database must be analyzed for changes:

- Logs that have been closed since the last update will be copied to the Archive.

- Logs which have been closed, but are still within the 14-day operational database, and have been updated since the last Archive update, will be updated in the Archive.

- Logs that remain open, and have been updated since the last update, will be updated in the Archive.

- For logs that remain open, and have not been updated since the last update, no data transfer will take place.

The flow pictured below shows the process.

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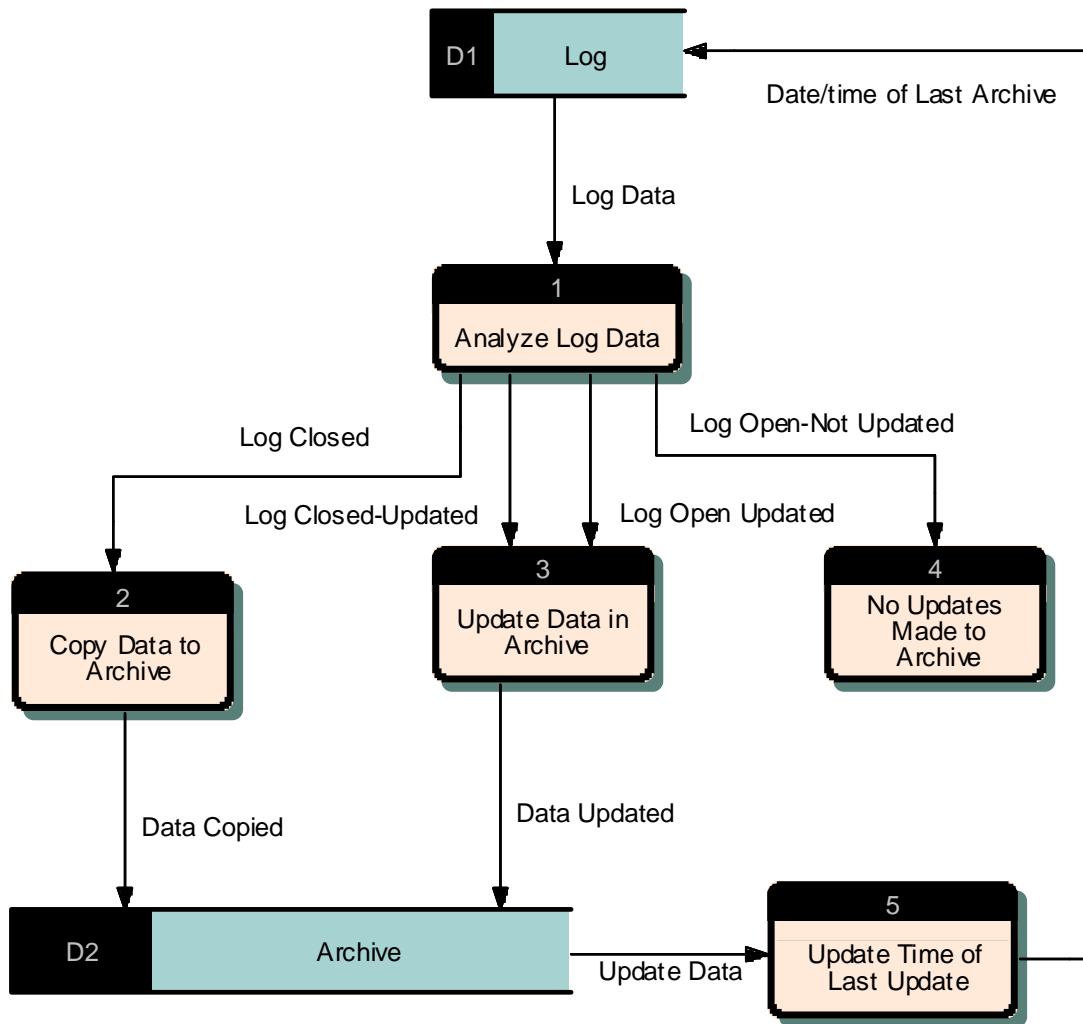
Figure 2-144. Archive Update – Update Log Data

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2.2.4.10.1.3 Real Time System Update – Delete

The Real Time System Update-Delete process is a custodial process. In order for the real time system to remain optimized, it is necessary to keep it manageable in size. To accomplish this, only 14 days of data will be kept in the database.

Once the Day 15 data has been copied to the Archive, Day 1 data is deleted from the operational database. The only data that will not be deleted are logs that are still open.

Operational Database Update - Delete -- 12/8/99
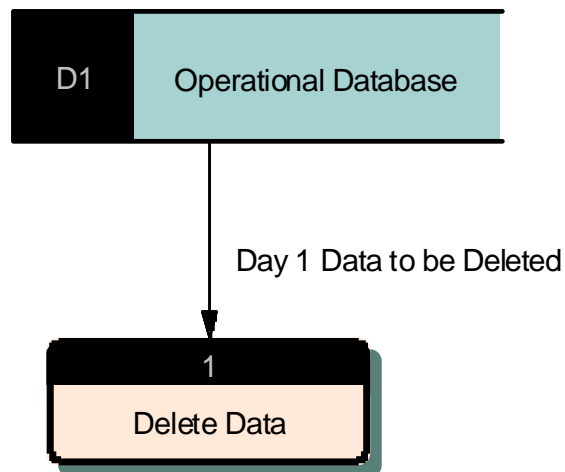
Figure 2-145. Real Time System Update - Delete

2.2.4.10.2 Reports

The Reports section is separated into two groups: Operational Reports, and Reports From Archive.

2.2.4.10.2.1 Operational Reports

The Operational Reports process group includes those processes that provide reporting capabilities to CHART users in the areas of operational reports, administrative reports, and management/statistical reports. The data for these reports will be taken directly from the real time system, which contains 14 days of data plus data for all logs that remain open.

For the purposes of the BAA Report, it is assumed that CHART II will utilize a commercial-off-the-shelf (COTS) package as a report development and generation tool. This position further assumes that the COTS package will provide process capabilities for the input of selection or filtering data and will provide on-screen viewing and hard copy printout capabilities. This COTS approach reduces the Reports process flow to a description of the steps for the user to take to select the specific report to be produced.

The Reports process provides the user with the capabilities to select a report from one of three lists of reports. Once a report is selected, the operator will interface with the COTS report writer to define the selection criteria for the report (if required), to select the number of copies, and to direct the report to a specific printer.

The specific reports defined are the following:

Operational Reports
1. Center Situation Data
2. Disabled Vehicle Log
3. Incident Log Report

Administrative Reports
1. Device Report
2. Device Failure Report
3. User Activity Report
4. Center Activity Report
5. Communications Log Report
6. Device Configuration Report

Management/Statistical Reports
1. DMS Usage Classification Report
2. DMS Usage Message Type report
3. HAR Usage Classification Report
4. HAR Usage Message Type Report
5. ERU/ETP Assist Type Report
6. ERU/ETP Total Assists Report
7. ERU/ETP Average Response Times

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8. Incident Clearance Time Report
9. Incident Roadway Capacity Restoration Report
10. Incident Duration by Type
11. Alarm Acknowledgement Report
12. Detection Subsystem Report
13. Shop Equipment Report

Reports - 10/6/99

Figure 2-146. Reports

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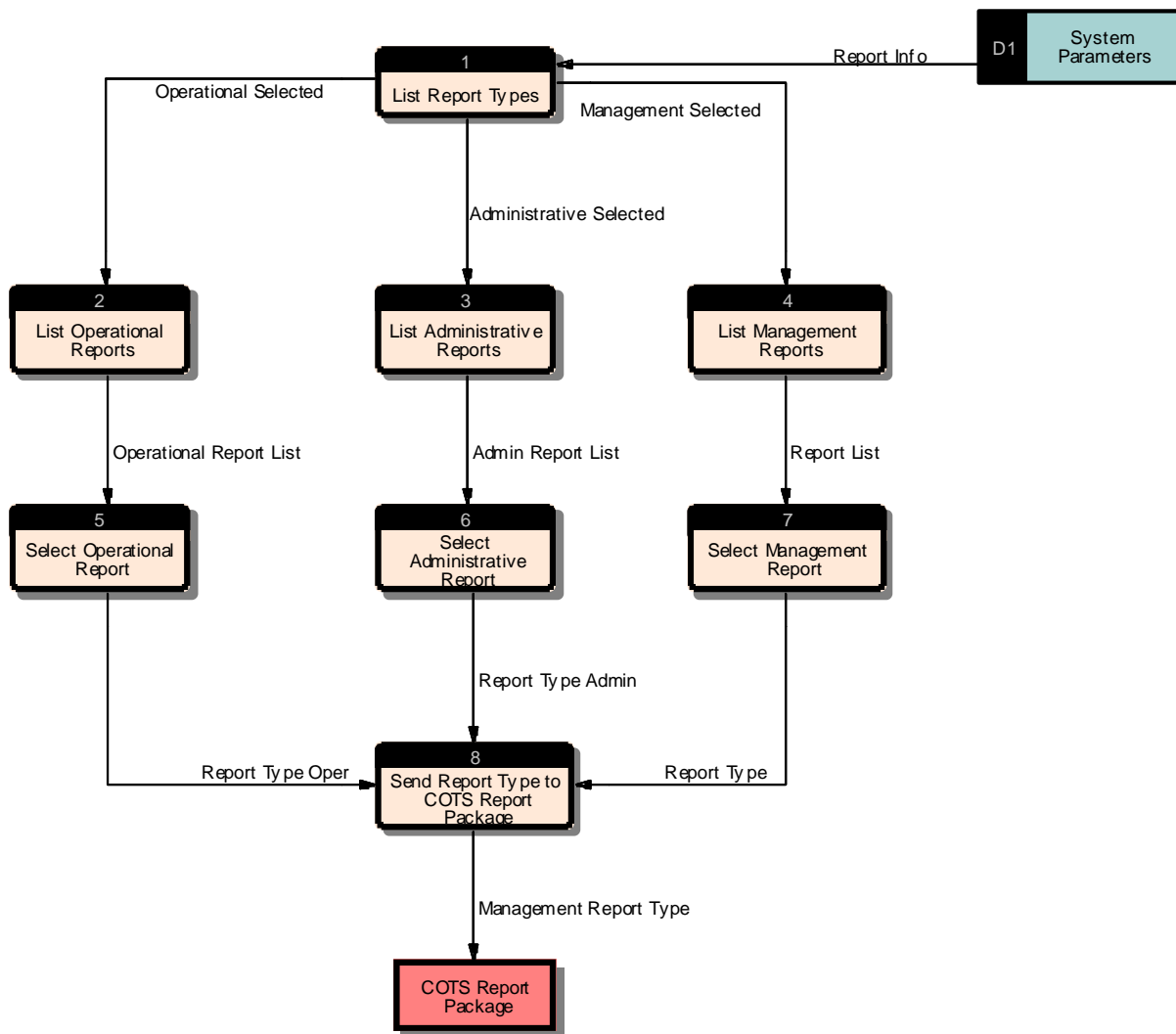
2.2.4.10.2.2 Reports from Archive

In addition to the standard reports identified in Section 2.2.4.10.2.1 Operational Reports, the following reports will be needed:

Operations
1. Weather detectors/road conditions
2. Percent down (system components, devices)

Management
1. Workload reports (open vs. activities)
2. Resource utilization (ETP vs. Logs, coverage area)
3. Cost of Incident Clearance (cost based on duration and dispatched vehicles)

Performance Management
1. Meantime to clear incidents/congestion

Reporting Characteristics/Types
1. Interface to allow users to select what they want and for what timeframe.
2. Access to all information captured:
   - Signs displayed
   - Logs
   - Detector information
   - Sensor data
3. Logs reports
4. Detection data and graphs (traffic flows)
5. Geographical selection
6. Recurring vs. Ad Hoc reports
7. Paper reports and electronic reports (converted to file for e-mail)
8. E-mail capability once report generated
9. Reporting of report usage

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2.2.4.11 Simulation

The University of Maryland has responsibility for the development of simulation tools for the CHART II system. This section of the BAA presents the conceptual approach to simulation to identify the uses of simulation and integration of the simulation tools into the overall CHART II system.

As discussed in a BAA workshop, simulation can provide tools to CHART in support of traffic management and the operational system defined in this BAA report. A summary of the support that simulation can provide is reflected in the following paragraph.

- Assist CHART II operators in a number of ways:
  - ➢ Assist with incident management and decision making
  - ➢ Represent lags in detector information to give a graphical representation of traffic flows
  - ➢ Estimate queue data on traffic congestion to tell how quickly a queue will clear
  - ➢ Allows for "what if" scenarios for handling situations differently
  - ➢ Change signal timing on secondary roads during an incident or congestion situation
- Evaluate results of incident management and suggest improvements
- Gather metrics for future road planning
- Assist traffic planners with adjusting signal timing to improve traffic flows

The following diagram illustrates the conceptual relationships between the CHART operational system (highlighted in gray) and the simulation support tools. As illustrated, the simulation component utilizes real-time, archive and map data from the operational system to perform its functions, and outputs estimates, predictions, comparisons, and simulations in support of various aspects of traffic and roadway management for SHA and other MDOT agencies.
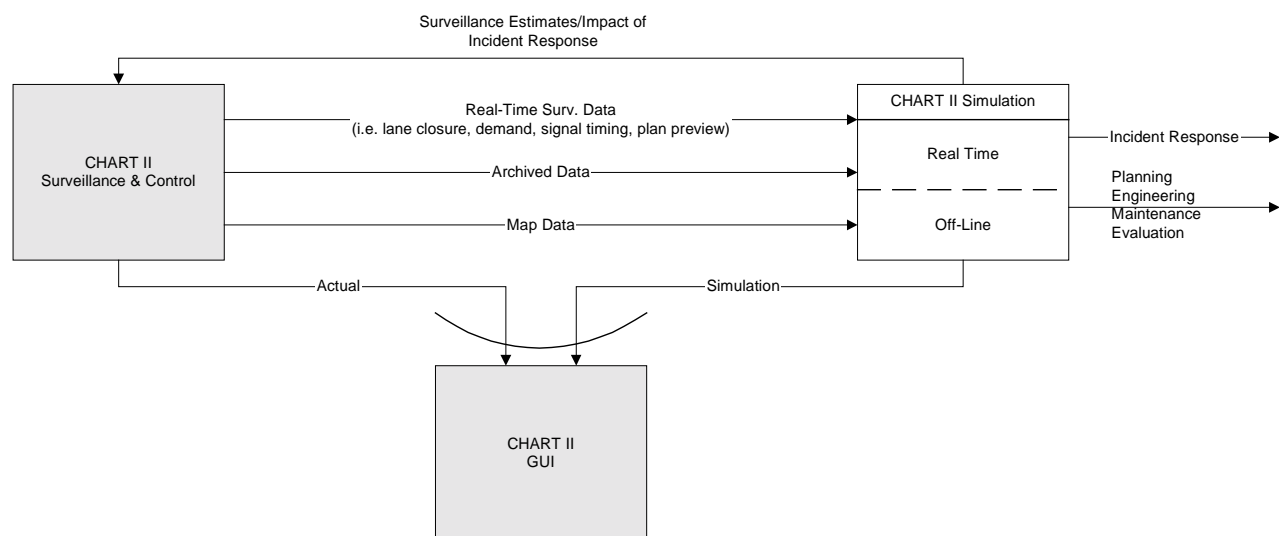
It was determined that simulation should be capable of providing three modes of support: Real-Time, Off-Line, and Training. These three modes are discussed in more detail in the following paragraphs.

2.2.4.11.1 Real-Time Mode

Real-Time mode is intended to provide simulation and decision support capabilities to support ongoing traffic management activities. As operators work a particular traffic management problem, they should be able to switch to the simulator in Real-Time mode and obtain evaluations of their current response plan as well as estimates of certain parameters that could affect the effectiveness of their response plan. By using inputs (*i.e.,* real-time surveillance data, archived data, map data) from CHART II, the simulator will give the CHART II operators the ability to bring up the current response plan in the simulator. The simulator should be able to evaluate the effectiveness of the current response plan based on past experience calculated from the Archive data. The simulator should also be able to predict traffic conditions as a result of the response plan, recommend changes to the response plan and project the resulting traffic conditions over time periods as the traffic situation continues or is affected by other projected conditions or the response plan.

The simulator needs to take into account other planned activities that might affect the response plan as the plan is implemented; such as planned special events and expected roadwork closures. The simulator should provide the operator with the reasoning behind its recommendations (*for example,* identify that the congestion or queue will increase because a special event or recurring congestion is expected in the next 30 minutes, *or* it is the normal phenomenon of the current situation). Operators should also be able to tweak the current or suggested response plan (using the same CHART II-type functions) to evaluate and build a better response plan, then be able to optionally modify and implement that enhanced plan when switching back into operational mode.

The use of the Real-Time simulation mode would usually be used for incident management and non-recurring congestion situations. It is expected that the simulation and decision support capabilities would assist the operators in these areas:

- DMS – when to post messages, where and when to change/clear messages
- Fill in surveillance (detector) gaps with estimates based on Archived data analysis, redirection of traffic, and planned special events or roadwork
- Signal timing recommendations where appropriate
- Secondary roads – surveillance estimates and signal timing recommendations
- Estimate future traffic conditions – queues, travel times
- Assistance with estimating movement of backup queue due to congestion/incident

It is expected that the Archive data will form the basis for the historical analysis and best practices capabilities of the simulator. It should be expected that the output results from the simulator would become more accurate over time as the Archive data increases. Some balance/priority needs to be considered in defining CHART II system releases in starting to collect Archive data as early in the release strategy as possible, but without delaying critical operational capabilities.

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2.2.4.11.2 Off-Line Mode

The Off-Line simulation mode is expected to provide capabilities to analyze a specific past traffic situation and propose or evaluate the response plan; also to provide for the exercising of proposed response plans or scheduled events to validate their expected results.

This mode will provide capabilities for evaluating how a past traffic situation was handled and then have the simulator suggest ways to improve the response. A past traffic situation should be able to be "replayed" and altered to see if the situation had been handled in a different way what the expected outcomes would have been. The simulator is expected to offer recommendations and critiques of the response activities based on analysis of the situation *as it happened*, and determine the effects of revisions to the response plan.

This mode should provide a means for an operator to input "what-if" scenarios to evaluate and adjust a proposed plan or scheduled event before entering or modifying it into the operational system. The simulator is expected to play the scenario and highlight problem areas and make suggestions for improving the plan. Once a plan is simulated to the satisfaction of the operator, there should be a way for the operator to save that plan to the operational system.

2.2.4.11.3 Training Mode

Training is the third simulation mode. It is possible that an operator could be trained in managing specific traffic situations through the use of simulation. In this mode, the simulator is expected to present a set of specific traffic situations and then allow the operator to react to each of the situations. Several traffic situation scenarios can be established (with variables to prevent the same response plan from being anticipated) and played out for the trainee to devise and implement response plans. The simulator should be able to evaluate the response plans as the steps are executed and evaluate the results. It should also be possible to simulate changing conditions as the situation progresses and critique the performance of the trainee at the conclusion of the exercise. It is assumed that training scenarios and reactions to response plans would be based on best practices derived from information in the Archive database in order to provide training specifically tailored to the CHART environment.

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2.2.4.12 Other Agencies

The ability of other agencies to receive/provide information from/to CHART II was discussed in one of the Design Workshops. Discussions with the other agencies have not been extensive yet, so there are no hard requirements to be introduced at this point. Detailed requirements and associated process flows will be developed during more in-depth discussions over the coming months.

The current list of agencies considered in the process design workshops, are the following:

- Montgomery County

- Virginia Department of Transportation (VDOT)

- Partners in Motion (PIM)

- Transcom

- 911 Centers

Montgomery County

CHART currently allows Montgomery County to view and control CHART's cameras via AVCM, but CHART is only able to receive feed from one of their cameras.

It would be desirable to have the following available:

- Real-time detector data from Montgomery Co. detectors on FITM routes.

- Splats of incidents in Montgomery Co., especially on FITM routes.

- Since Montgomery Co. has some of the same PDMS it would be appropriate to have them integrated into CHART II.

- Would like to get cameras from MC TMC on a larger scale, control of some cameras

VDOT

There is currently no information being shared between VDOT and CHART.

It would be desirable to have the following available:

- Ability to view cameras (*a minimum requirement*)

- Detector data

- Incident data

- Sign data

This would include information for routes other than just the Capitol Beltway (I-495), such as I-95S, I-66, Route 7, etc.

PIM

On 1/1/2000, PIM will probably be going private. Additional requirements will be defined once this takes place and more is known about what information is being collected.

TRANSCOM

It would be desirable to have access to data for any incident that affects travelers to and from the state of Maryland, so information could be parsed and posted in CHART II Incident Logs, as well as overlay map data.

911 Centers

It is possible that CHART II Incident Logs could be generated from the information being stored in the 911 Center databases. It would be beneficial to have access to 911 Center databases, so information could be parsed for incident related calls in order to post incident data.

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3 Organization Model View

This section presents the Organization Direction Model consisting of the principles, constraints and assumptions to be considered in the design and development of the CHART II application. It is not the intent of this BAA exercise to analyze and recommend a re-organization of the CHART organization.

3.1 Organization Direction Model

This model shows what organization principles, constraints, and assumptions impact the project.

3.1.1 Organization Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The table below shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶   Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷   To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸   Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	Device owner will always have overriding control of devices
❶	Anybody may initiate an incident
❶	Everyone with appropriate CHART access can see incident data and add to the status of the incident
❶	The CHART "response plan" will be displayed for initiation at only one location, which will be the "active zone of responsibility"
❶	There will be one designated System Administrator who can make adjustments as necessary and configure zones of responsibility
❶	There will be a "Chief Operator" function to arbitrate conflicts
❶	TOCs and SOC will have the same information and rules
Constraints	
	None

Assumptions	
❶	Personnel will receive training on how and when to access CHART data.

3.2 Organization Model

This section presents the organization structure for CHART and specifies the expected duties of the organizational entities as related to the deployment of a new CHART system.

The following diagram depicts the CHART Organization as pertinent to the discussions of this section.

CHART Organization Chart
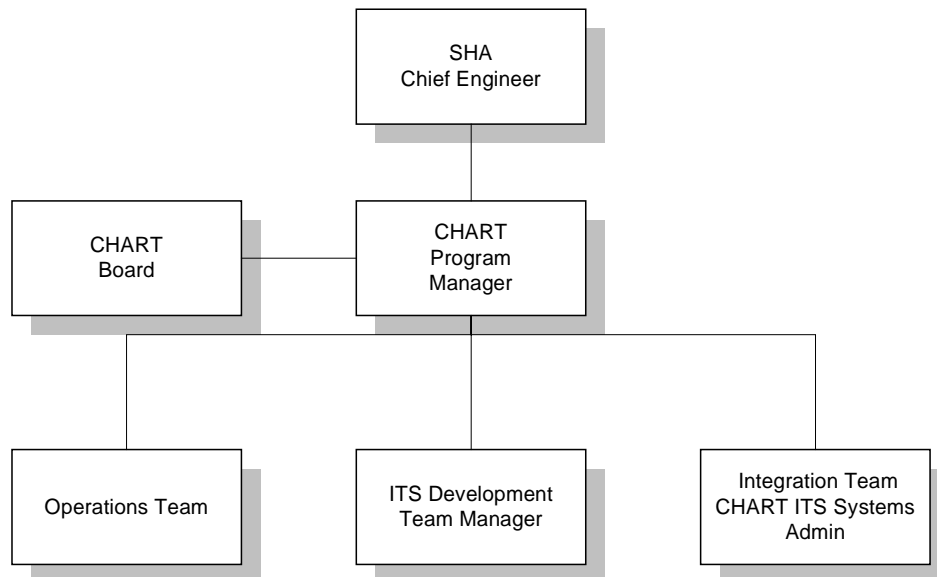
It was mentioned in Visioning and Process Design Workshops that there is a need for a "Chief Operator" position in the CHART organization to arbitrate conflicts and be the main point of contact for internal and external customers when responding to traffic incidents. It is envisioned this position would be filled at all times (24 x 7) and would be responsible for coordinating intra-agency activities; and serve as a single point of contact to coordinate and take responsibility for inside operations (device activation and resource notification). This position would also alleviate the problem of those times when calls for information come in and no single point of contact (team leader) is available to handle this responsibility by being the point of contact for information requests.

The following table identifies the major responsibilities of the organizational entities as related to the deployment, management and operation of the CHART system described in the other sections of this document. The responsibilities identified in this table also

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reflect many of those responsibilities necessary to continue the growth of CHART as well as support the continuing efforts to further integrate other systems and transportation modals into a state-wide ITS.

Organizational Entity	Major Responsibilities
SHA Chief Engineer	• Strategy and Planning • Manage budget and funding • Define business objectives
CHART Program Manager	• Strategy and Planning • Manage budget and funding • Define, measure, and manage business objectives • Define and monitor operational objectives
Operations Team	• Traffic management of state highways and arterials • Manage ETP, ERU and HOT operations • Monitor, measure, and manage operational accomplishments • Plan, prepare, and conduct ER training
ITS Development Team Manager	• Investigate new technologies • Develop ITS strategy • Define ITS objectives • Manage ITS development and deployment
Integration Team – CHART ITS Systems Admin	• ITS Systems planning and strategy • Maintain infrastructure equipment and configuration • CHART application administration and configuration • Network administration and maintenance • Legacy systems administration • Applications change control and configuration management • CHART application maintenance • Database administration • CHART functional and user training

Many of the major responsibilities noted above for the Integration Team – CHART ITS System Admin organization are expected to be supported by contract personnel during the development of CHART II and afterwards as part of application maintenance and hardware maintenance contracts. The following responsibilities have been identified as candidates for contract support, during both development and maintenance phases:

- Maintain infrastructure equipment and configuration

- Network administration and maintenance

- Applications change control and configuration management

- CHART application maintenance

- Database administration

- CHART functional and user training.

3.3 Training Requirements

Deployment of a new system has an adverse affect on the organization unless appropriate training is provided to the organization. The CHART II system is based on re-engineered processes, new applications and user interface techniques, and a new hardware and operating systems architecture. With so many of the aspects of the new system being different from the old system and system environment, several types of training will be required to prepare the organization to effectively utilize, administer, and maintain the system. Types of training are described in the following paragraphs.

3.3.1 Technical training

3.3.1.1 Windows NT 4.0:

Two types of Windows NT 4.0 training should be provided. One type is for system administrators to provide them the necessary skills to configure servers, workstations, and users. A second type is for users to provide them the necessary skills to manipulate Windows-based applications.

3.3.1.2 Other technical training

It has been indicated that selected members of the CHART staff will require additional technical training to provide system support to the CHART operations. These selected individuals require, at a minimum, basic technical training on all systems and hardware components of the CHART II system. Examples of other technical training include UNIX, Oracle, ATM Switch, Coastcom Mux, Routers, etc.

3.3.2 Functional Training

3.3.2.1 CHART Application Administration:

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This training should provide a functional overview of the system parameters and configuration data used in the CHART applications to control the processing options and flexibility of the applications. Training should identify the specific parameters and configuration data that may be maintained, the values of each parameter and configuration type, and their affect on the applications.

3.3.2.2 CHART User Functions:

This training should provide the users with a conceptual view of the processes supported by the CHART applications. Training should introduce the users to any new terminology, descriptions of the appropriate situations to utilize each function, and the business objectives and reasons for performing each function. This training should be directed to SOC, TOC, and AOC operators; Maryland State Police; and SHA Maintenance Shops operators.

3.3.2.3 CHART Archive Data:

This training should provide users with an overview of the data being retained in the Archive Database and its logical structure and relationships. Training should also include example usage of the data to obtain performance measurement and statistical data. This training should be directed to CHART managers and supervisors, and other non-CHART agencies who have expressed a need for access to the archived data.

3.3.3 User Application Training

3.3.3.1 CHART Application User Training:

This training should provide CHART users with application level training. Training should be directed to training operators in the use of the CHART II applications at a screen level. This training may include Windows and/or Oracle training as related to the applications and the current knowledge of the operators. User training should be related to the functional training so as to provide the operators with continuity between the two types of training.

3.3.3.2 CHART Archive Training

This training should be provided to CHART managers and interested SHA/MDOT Archive users. Training should be directed toward use of standard and alternative tools to select, extract, and report on data in the Archive.

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4   Location Model View

This section presents various model views of the Location domain of change derived from CHART II visioning and process design workshops. The Direction Model provides the principles, constraints and assumptions that guide the design of business processes, while the Conceptual Model provides the specifics of business processes defined and derived as related to specific Locations.

4.1   Location Direction Model

This model shows what location principles, constraints, and assumptions impact the project.

4.1.1   Location Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The table, which follows below, shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶   Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷   To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸   Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	Each location has one point of control for all data
❶	Ability to expand the number of locations that have access to CHART data
❶	System will provide for remote access capability – possibly with reduced functional capabilities
❶	Failure at one location will not disable all locations
❶	System will provide the capability to transfer control between locations
Constraints	
	None
Assumptions	
❶	MDOT network access rules support desired capabilities

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4.2 Conceptual Location Model

The Conceptual Location Model defines and identifies types of locations represented in the business processes and provides a matrix of the allocation of business processes to the location types. Additionally, this Location Model includes a diagram of the operation center hierarchy of responsibilities.

The business processes refer to a hierarchy of responsibilities in discussions related to maintaining operation centers and the processing of alerts. Primarily, this hierarchy defines which organization is responsible for managing/handling specific alerts/functions at times when the organization with the usual area of responsibility is unavailable to perform those responsibilities.

4.2.1 Location Types

From the Process Design Workshops, eight location types have been identified. The location types are:

- SOC/TOC/AOC/MTA – the SHA Traffic Operations Centers; system operations and traffic management

- Maryland State Police – all MSP locations participating in CHART; traffic management, incident response

- Districts/Counties – District and County Offices: primarily monitoring and information viewing, some perform highway maintenance supervision

- Media – outside information re-processors: primarily obtain filtered incident and traffic flow information, obtain CCTV video feeds, includes PIM and IEN

- SHA Highway Maintenance – highway maintenance shops responsible for structural repairs, road signs and posts, potholes, guard rails, etc; response to Action and Incident Logs

- Device Maintenance-Signal – signal control and repair shops; respond to Action Logs

- Device Maintenance-Radio (HAR) – radio maintenance shops; respond to failure alerts/Action Logs for HAR, Radar based detection, CCTV, and Weather Towers

- Device Maintenance-DMS – dynamic signs repair shop; respond to failure alerts/Action Logs for DMS, PDMS, ATR, and Shazam

4.2.2 Location-Process Matrix

The Location-Process Matrix illustrated in the following figures shows the processes, and indicates which processes will be operational at which types of locations. Where a process is identified as '*Not Applicable To A Location*', this means the process is viewed as being performed by the system and not a location.

			SOC/TOC/AOC/MTA (1)	Maryland State Police (2)	Districts/Counties (3)	Media (4)	SHA Highway Maintenance (5)	Device Maint. - Signal (6)	Device Maint. - Radio (HAR) (7)	Device Maint. - DMS (8)	Not Applicable To A Location (9)
SECURITY AND OPERATIONAL CONTROL											
	System Administration										
		a	Maintain Users	X								
		b	Maintain Roles	X								
		c	Maintain Functional Rights	X								
		d	Maintain Functional Responsibilities	X								
		e	Maintain Geographic Responsibility	X								
		f	Maintain Operations Center and AOR	X								
	Operational Control										
		a	Maintain Center Notepad	X								
		b	User Logon	X	X	X	X	X	X	X	X	
		c	View Center Situation	X				X	X	X	X	
		d	Maintain User Preferences	X	X	X	X	X	X	X	X	
		e	Maintain Operator's Notepad	X	X	X	X	X	X	X	X	
		f	Perform CHART Chat	X	X	X		X	X	X	X	
		g	Logout	X	X	X	X	X	X	X	X	
		h	Change User	X								
		I	Transfer Resources	X					X	X	X	
		j	Respond to Request to Transfer Resources	X						X	X	
	Configuration Processes										
		a	Maintain System Parameters	X								
		b	Maintain Links	X								
	FITM Plans										
		a	Maintain FITM Plans	X								
	Map Configuration										
		a	Update MDOT GIS Map Data	X								
SYSTEM CONFIGURATION AND STATUS											
	Components										
		a	Maintain Component Configuration	X								
		b	Log System Failures									X
	Devices										
		a	Maintain Device Configuration	X								
		b	Set Device Online	X				X	X	X	X	
		c	Set Device Offline	X				X	X	X	X	
		d	Set Device to Maintenance Mode	X				X	X	X	X	
		e	Handle DMS and HAR Polling Results									X
		f	Respond to Device Failure Alerts	X				X	X	X	X	
INCIDENT/EVENT MANAGEMENT											
	Logs										
		a	Log Communications Log	X	X	X		X	X	X	X	
		b	Log Action Log	X	X	X		X	X	X	X	
		c	Log Disabled Vehicle Log	X	X	X		X				

Figure 4-1. Location-Process Matrix, Part 1/4

		Process	SOC/TOC/AOC/MTA (1)	Maryland State Police (2)	Districts/Counties (3)	Media (4)	SHA Highway Maintenance (5)	Device Maint. - Signal (6)	Device Maint. - Radio (HAR) (7)	Device Maint. - DMS (8)	Not Applicable To A Location (9)
	d	Log Incident Log	X	X	X		X				
	e	View Historical vs. Current	X	X	X		X				
	f	Log Congestion Log	X	X	X		X				
	g	Log Recurring Congestion Log	X	X	X		X				
	h	Log Special Event Log	X	X	X		X				
	i	Log Weather Advisory Log	X	X	X		X				
	j	Log Weather Sensor Log	X	X	X		X				
	k	Log Safety Message Log	X	X	X		X				
	g	View Log	X	X	X		X	X	X	X	
	h	Close Log	X	X	X		X	X	X	X	
Location Navigation											
	a	Maintain Location Navigation Data	X								
	b	Activate Location Navigator	X	X	X		X	X	X	X	
Queues											
	a	Calculate Queue Length	X	X	X		X				
Notification											
	a	Maintain Notification List	X								
	b	Perform Notificaiton	X	X	X		X	X	X	X	
SHARED RESOURCE MANAGEMENT											
DMS/HAR Common Processes											
	a	Maintain Acceptable Word Dictionary	X								
	b	Maintain Unacceptable Word Dictionary	X								
	c	Perform Responsibility Reminder	X	X							
	d	Respond to Responsibility Reminder Alert	X	X							
DMS Processes											
	a	Maintain DMS Message Library	X								
	b	DMS – Add a Message	X							X	
	c	DMS – Remove a Message	X							X	
	d	DMS – Arbitrate Message Queue									X
	e	DMS – Evaluate Queue									X
	f	DMS – Send a Message									X
	g	DMS – Blank a Sign									X
	h	DMS - Reset	X							X	
	i	DMS – Restore Message									X
	j	DMS- Override Queue	X								
HAR Processes											
	a	Maintain HAR Message Library	X								
	b	HAR – Add a Message	X						X		
	c	HAR – Remove a Message	X						X		
	d	HAR – Arbitrate Message Queue									X
	e	HAR – Evaluate Queue									X
	f	HAR – Broadcast a Message									X

Figure 4-2. Location-Process Matrix, Part 2/4

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The column legend (read diagonally top to bottom):

- 1 = SOC/TOC/AOC/MTA
- 2 = Maryland State Police
- 3 = Districts/Countiies
- 4 = Media
- 5 = SHA Highway Maintenance
- 6 = Device Maint. - Signal
- 7 = Device Maint. - Radio (HAR)
- 8 = Device Maint. - DMS
- 9 = Not Applicable To A Location

			1	2	3	4	5	6	7	8	9
	g	HAR – Broadcast Default Message									X
	h	HAR – Set Shazam On/Off									X
	i	HAR – Update Default Message	X								
	j	HAR – Send Maintenance Command							X		
	k	HAR – Restore Message									X
	l	HAR - Override Queue	X								
AVCM											
	a	Maintain Wall Monitor Configuration	X								
	b	Control Wall Monitor Assignment	X	X	X		X	X	X	X	
	c	Maintain CCTV Presets	X								
	d	Refresh Default AVCM Presets									X
	e	Maintain Tours	X								
	f	Activate Tour	X	X	X		X	X	X	X	
	g	Control Camera	X	X	X		X	X	X	X	
Detectors											
	a	Handle Polled Detector Data									X
	b	Handle Detector Rules									X
	c	Generate Congestion Response									X
	d	Respond to Congestion Alert	X								
	e	Generate Incident Response									X
	f	Respond to Incident Alert	X								
	g	Activate Response Plan									X
Equipment											
	a	Maintain Equipment Inventory	X		X		X	X	X	X	
	b	Maintain Equipment Status	X		X		X	X	X	X	
	c	Alert For Delinquent Equipment Status									X
	d	Respond to Delinquent Equipment Status Alert					X	X	X	X	
Signals											
	a	Handle Signal Polling Data									X
	b	Respond to Exceeded Signal Threshold Alert	X					X			
	c	Download Signal Data									X
AVL											
	a	Handle AVL Polling Results									X
	b	Perform AVL Function Processing									X
	c	Process AVL In/Out of Service Message									X
	d	Process AVL Mayday Message									X
	e	Process AVL Arrival On-Scene Message									X
	f	Process AVL Assist Disabled Vehicle Message									X
	g	Process AVL Assist Disabled CHART Vehicle Message									X
	h	Process AVL Available Message									X
	i	Respond to AVL Alerts									
	j	Respond to Mayday Alert from AVL	X								
	k	Respond to Arrival On-Scene Alert from AVL	X								

Figure 4-3. Location-Process Matrix, Part 3/4

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Process	SOC/TOC/AOC/MTA	Maryland State Police	Districts/Countiies	Media	SHA Highway Maintenance	Device Maint. - Signal	Device Maint. - Radio (HAR)	Device Maint. - DMS	Not Applicable To A Location
	1	2	3	4	5	6	7	8	9
l Respond to Disabled Vehicle Alert from AVL	X								
ALERTS									
a Send Manual Alert	X	X	X		X	X	X	X	
b Send Alert									X
c Escalate Alert									X
PLANS									
a Maintain Plans	X								
b Activate Plan	X								
c Deactivate Plan	X								
SCHEDULED EVENTS									
a Maintain Scheduled Events	X								
b Process Scheduled Events Start									X
c Process Scheduled Events End									X
EORS INTERFACE									
Construction									
a Download EORS Permits									X
b Activate EORS Icon On Map									X
c Activate EOR Permit	X								
Snow Emergency									
a Maintain Snow Emergency Declaration	X								
Phone Book									
a Access Phone Book	X	X	X		X	X	X	X	
WEATHER SUPPORT									
National Weather Service									
a View National Weather Service Data	X	X	X		X	X	X	X	
b Process Weather Alerts From The NWS									X
c Respond to National Weather Service Alert	X	X	X		X	X	X	X	
d Fax Weather Report									X
SCAN									
a Handle Weather Sensor Data									X
b Generate Weather Sensor Response									X
c Respond to Weather Sensor Alert	X								
ARCHIVING AND REPORTS									
Archiving									
a Archive Update - Add									X
b Archive Update - Update Log Data									X
c Real Time System Update - Delete									X
Reports									
a Operational Reports	X	X	X		X	X	X	X	
b Reports from Archive	X	X	X		X	X	X	X	

Figure 4-4. Location-Process Matrix, Part 4/4

4.2.3 Location Hierarchy

The Location Hierarchy is a representation of the different locations in which users for the CHART workstations will be needed for varying tasks.

The hierarchy shown below indicates the division of locations by major location groups (shaded) as discussed in the design workshops.

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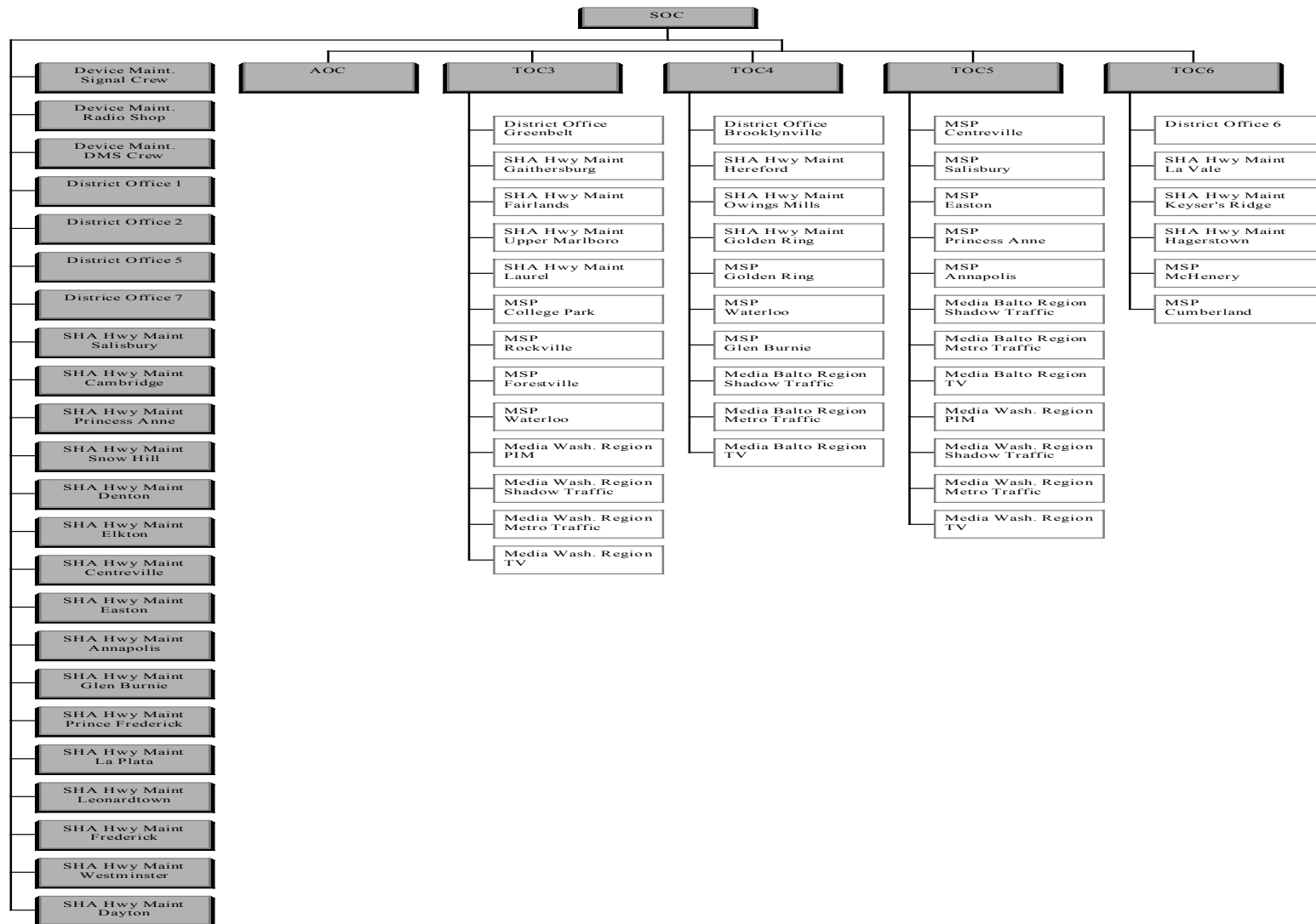
Figure 4-5. CHART II, Location Hierarchy

The hierarchy chart shows the following structure:

SOC (top level)

Device Maint. Signal Crew (left branch, with the following items):
- Device Maint. Signal Crew
- Device Maint. Radio Shop
- Device Maint. DMS Crew
- District Office 1
- District Office 2
- District Office 5
- Districe Office 7
- SHA Hwy Maint Salisbury
- SHA Hwy Maint Cambridge
- SHA Hwy Maint Princess Anne
- SHA Hwy Maint Snow Hill
- SHA Hwy Maint Denton
- SHA Hwy Maint Elkton
- SHA Hwy Maint Centreville
- SHA Hwy Maint Easton
- SHA Hwy Maint Annapolis
- SHA Hwy Maint Glen Burnie
- SHA Hwy Maint Prince Frederick
- SHA Hwy Maint La Plata
- SHA Hwy Maint Leonardtown
- SHA Hwy Maint Frederick
- SHA Hwy Maint Westminster
- SHA Hwy Maint Dayton

AOC

TOC3:
- District Office Greenbelt
- SHA Hwy Maint Gaithersburg
- SHA Hwy Maint Fairlands
- SHA Hwy Maint Upper Marlboro
- SHA Hwy Maint Laurel
- MSP College Park
- MSP Rockville
- MSP Forestville
- MSP Waterloo
- Media Wash. Region PIM
- Media Wash. Region Shadow Traffic
- Media Wash. Region Metro Traffic
- Media Wash. Region TV

TOC4:
- District Office Brooklynville
- SHA Hwy Maint Hereford
- SHA Hwy Maint Owings Mills
- SHA Hwy Maint Golden Ring
- MSP Golden Ring
- MSP Waterloo
- MSP Glen Burnie
- Media Balto Region Shadow Traffic
- Media Balto Region Metro Traffic
- Media Balto Region TV

TOC5:
- MSP Centreville
- MSP Salisbury
- MSP Easton
- MSP Princess Anne
- MSP Annapolis
- Media Balto Region Shadow Traffic
- Media Balto Region Metro Traffic
- Media Balto Region TV
- Media Wash. Region PIM
- Media Wash. Region Shadow Traffic
- Media Wash. Region Metro Traffic
- Media Wash. Region TV

TOC6:
- District Office 6
- SHA Hwy Maint La Vale
- SHA Hwy Maint Keyser's Ridge
- SHA Hwy Maint Hagerstown
- MSP McHenery
- MSP Cumberland

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5 Application Model View

This section presents various model views of the Application domain of change as gathered from CHART II visioning workshops derived from analysis of the business processes. The Direction Model provides the principles, constraints and assumptions that guide the design of applications, while the Conceptual Model provides the specifics of the application design.

5.1 Application Direction Model

This model shows what application principles, constraints, and assumptions impact the project.

5.1.1 Application Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The table below shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶   Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷   To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸   Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	Open application architecture
❶	Distributed applications to increase fault tolerance
❶	Designed for functional expansion of devices, modules (functionality), and graphical capabilities
❶	Common user interface for all functions, including legacy systems
❶	Easy to use interface for system configuration
❶	Device control may be available from any workstation
❶	Configurable user rights including zones of responsibility
❷	System feedback will be provided for each user action (both positive and negative feedback)
❶	System will notify user of preset alarms
❶	System will be self-monitoring and attempt self-recovery
❶	System must automate resetting of traffic control devices and traveler information devices at clearance of an incident

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	Principles
❷	Device communications must take place at the closest available location
❶	Minimize user steps to accomplish system functions
❶	System will maintain incident response plans
❶	System shall not allow unauthorized access to user functions and data
❶	System will support simulation and preview mode
❶	System will interface with the Signal Control System
❶	Simulation will be an off-line process
❷	FITM maps shall be overlays to CHART map
❶	System will provide decision support-type operator support
❶	Code will be written to appropriate standards and be fully documented
❶	Automate system maintenance activities to the extent possible
❶	Application will be compliant with ITS Standards
❶	Failure of one process will not force the failure of another process
	Constraints
❶	Must use SHA GIS data
❶	Must use existing field devices
	Assumptions
❶	There is an ORB that is standard and meets the needs of CHART II
❶	FMS will be in place, stable, and meets expectations
❶	Will be able to retrieve legacy system data
❶	AVCM will be in place, stable, and meets expectations

5.2 Conceptual Application Model

5.2.1 Application Architecture

The Application Architecture provides a conceptual description (at several levels of detail) of the application areas that will be required to satisfy the CHART II future business needs and the Commercial Off-The-Shelf (COTS) packages that are either current in use, or are targeted for use, to fulfill the needs.

5.2.1.1 Conceptual Application Architecture Diagram

The Application Architecture Diagram provides a high-level, graphical description of the characteristics that will be built into the application systems to satisfy future enterprise requirements. The diagram shown below represents, at a conceptual level, a high-level view showing the CHART II system and its external interfaces. The CHART II system gives and receives information to and from other sources which are linked to the system. The diagram below illustrates how the CHART II system will interface with legacy systems, as well as with other external interfaces, and COTS software. These applications assist the users of the CHART II system to monitor the roadways, notify individuals and groups that may need to assist with situations or be aware of what's happening, and receive additional information to assist with current or future situations.

CHART II Business Area Architecture Report   277   August 23, 2000
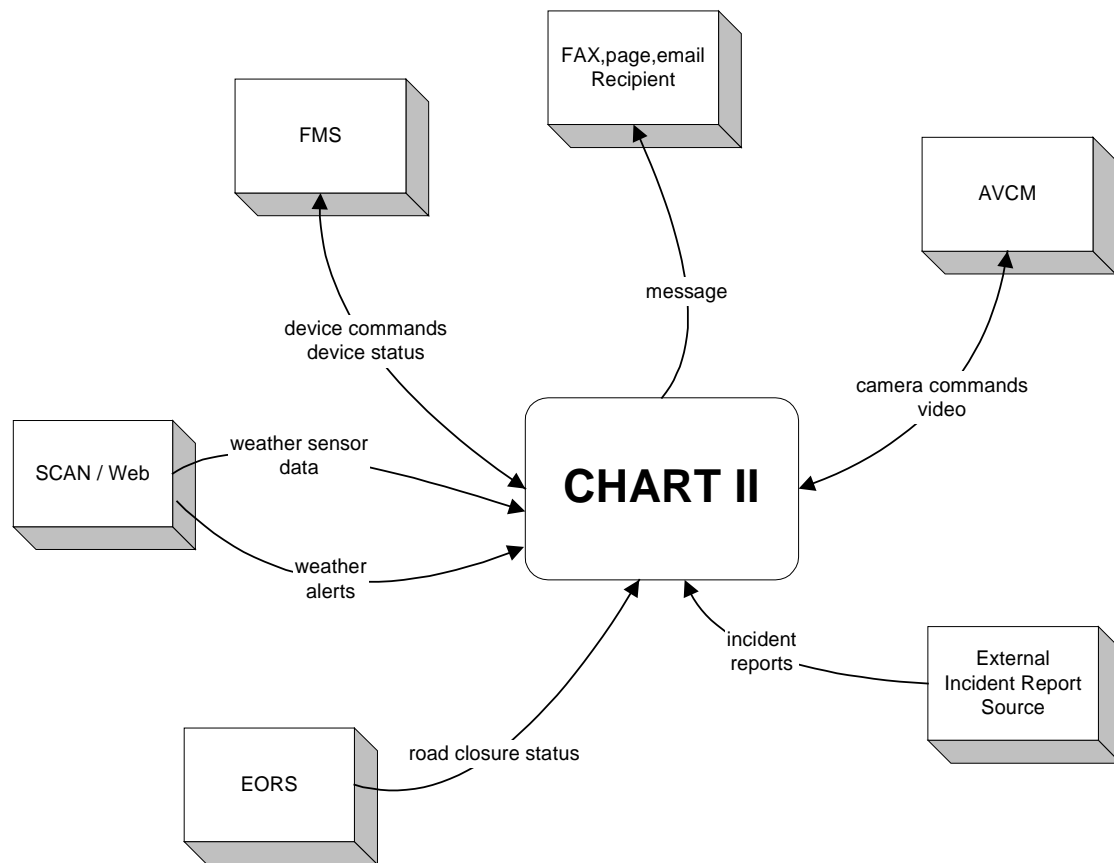
Figure 5-1. Application-level Diagram

Future releases of CHART II will also incorporate a CHART-Lite version of the application, and a Simulation application:

- CHART-Lite is seen to be a fully functional version of the application, that will be deployed anywhere, and communicate with the CHART II system. Although this has not been fully defined, the current vision is that it will be provided via a web interface for ease of use and cost reduction, since having a separate workstation deployed at multiple sites could be very costly and difficult to maintain.

- The University of Maryland will have responsibility for the development of simulation tools for the CHART II system. Further definition of requirements and development will be undertaken at a later date.

5.2.1.2 Conceptual Application Areas

Seven future application areas have been conceptualized and defined. A conceptual description of the application areas required to satisfy the CHART II future business needs is shown in the table below. Their order within the following table does not suggest a release sequence or development priority.

Application Area	Description
Traffic and Roadway Monitoring	Monitor traffic and roadway conditions and evaluate roadway detector data.
Incident Management	Provides the operator with tools to assist in incident management and documentation.
Shared Resource Management	Handle allocation and control of shared devices (DMS, HAR) and receive and log roadway detector data.
Status Display Management	Maintain the state of the display map.
System Configuration and Administration	Provides tools for managing and administering the system
Operations Support	Provides user access control and support utilities.
Report Generation	Provide tools for generating reports from system log files.

Figure 5-2. Future State Application Names

Each of the seven application areas are defined in detail in the following section of this report.

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5.2.1.3 Conceptual Application Area Definitions

For each of the application areas identified, there are four sections:

- Description
  A brief summary of the application area.

- Functions
  List of functions which will be performed by the application area.

- Interfaces
  A table representing the source/target for the application, the type of interface, and a description of the source/target type.

- Diagram for Application Area
  The diagram depicts the application area, external interfaces, and major data sources and links. The major data flows are shown in the diagram. Data flows considered part of the application infrastructure (*e.g.* logging of system messages) are not shown in this high level diagram. The diagram uses the following conventions:

    Circles represent the proposed future applications.

    Regular rectangles represent external agents or entities.

    Double horizontal lines represent databases.

    Arrows represent the flow of information.

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5.2.1.3.1 Traffic and Roadway Monitoring

Description:

The Traffic and Roadway Monitoring application area is responsible for the collection of data associated with monitoring traffic and roadway conditions, the analysis of this data, and issuing alerts for roadway congestion and incidents. The application compares current speed and traffic flow data with historical traffic flow data and weather information. It makes a determination whether or not congestion or a traffic incident has occurred on a roadway, determines the responsible center and operator, and issues an alert. The application periodically checks EORS for road closure and snow emergency information and the scheduled events list for scheduled events. It checks the National Weather Service for weather bulletins, alerts the operators if a bulletin has been issued, and initiates a FAX of the bulletin to a predetermined list of sites. As the status of objects such as detectors and links changes the state of the objects are updated so that the change may be reflected on the map display.

Functions:

- Analyze roadway detector data.

- Receive weather alerts.

- Receive weather sensor data.

- Receive road closure information.

- Receive snow emergency information.

- Generate traffic, weather, and incident alerts.

- Check for scheduled events.

- FAX weather report.

- Update state of objects.

Interfaces:

Source/ Target	Interface Type	Description
SCAN / Web	App-to-App	Receive weather sensor data from field devices, National Weather information from the SHA Web Page.
EORS	App-to-App	Receive road closure status.
Detector History	Data Store	Query traffic history data.
Shared Resource Management	App-to-App	Receive current detector data. Issue a traffic plan message if indicated by traffic or weather conditions.
Status Display Management	App-to-App	Update display icons.
Incident Management	App-to-App	Object status updates.
Operations Support	App-to-App	Retrieve user and center information for determining where to send alerts. Send weather report to be faxed.
Scheduled Events	Data Store	Retrieve scheduled event information.

Diagram for Traffic and Roadway Monitoring :
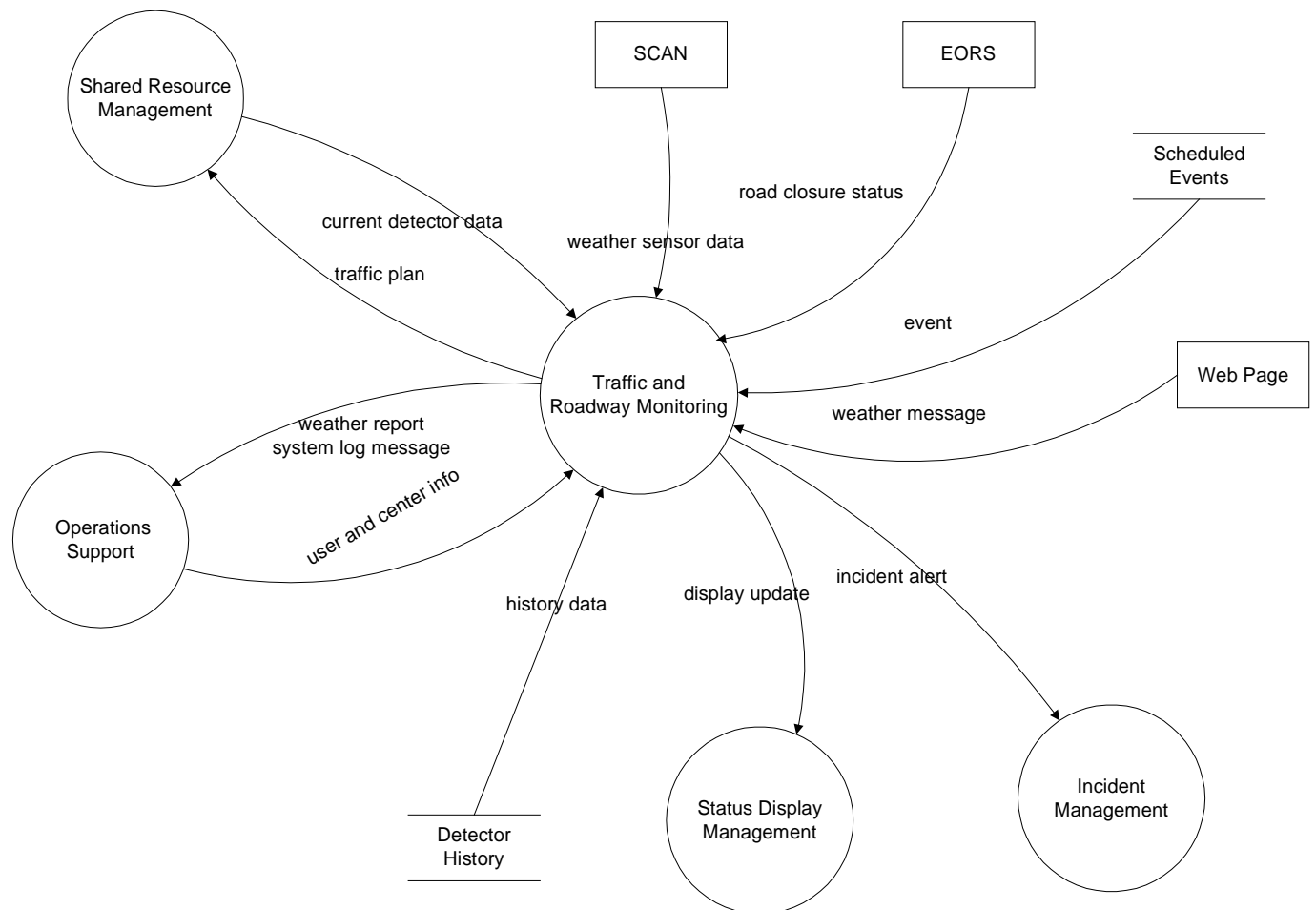
5.2.1.3.2 Incident Management

Description:

This application area handles those activities associated with managing an incident. Incidents are initiated either manually by the user or are automatically initiated by an alert received from the Traffic and Roadway Monitoring application. This application area provides the operator with an interface to log various types of messages; communications with those outside the center, communications received about non-blockage events and actions taken, communications received about disabled vehicles, and an incident management log for recording information about traffic incidents. It calculates queue length information for inclusion in an incident log entry. As a result of an incident the application may format a message for sending by page, FAX, or email to a list of recipients. It provides an interface for the user to select a plan to activate or to deactivate a plan that is currently active.

Functions:

- Create entries in the Communications log.

- Create entries in the Action log.

- Create entries in the Disabled Vehicle log.

- Create entries in the Incident Management log.

- Calculate queue length.

- Activate/deactivate a plan.

- Format text message for sending to page/FAX/email list.

Interfaces:

Source/ Target	Interface Type	Description
External Incident Report Source	External agent	The operator may receive reports of incidents from a number of outside sources such as #77 call-ins, the police, etc.
Comm log	Data Store	A log is maintained for recording communications with outside entities.
Actions log	Data Store	A log is maintained for recording actions taken for non-blocking events.
Disabled vehicle log	Data Store	A log is maintained with information on all disabled vehicle reports.
Incident log	Data Store	A log is maintained with information on all incidents.
Operations Support	App-to-app	Based on an evaluation of an incident a FAX, page, or email may be sent to a specified list of recipients.
Shared Resource Management	App-to-App	Issue an incident message for a confirmed incident. Receive current detector data for queue length calculation
Traffic and Roadway Monitoring	App-to-App	Receive an incident alert.

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Diagram for Incident Management :
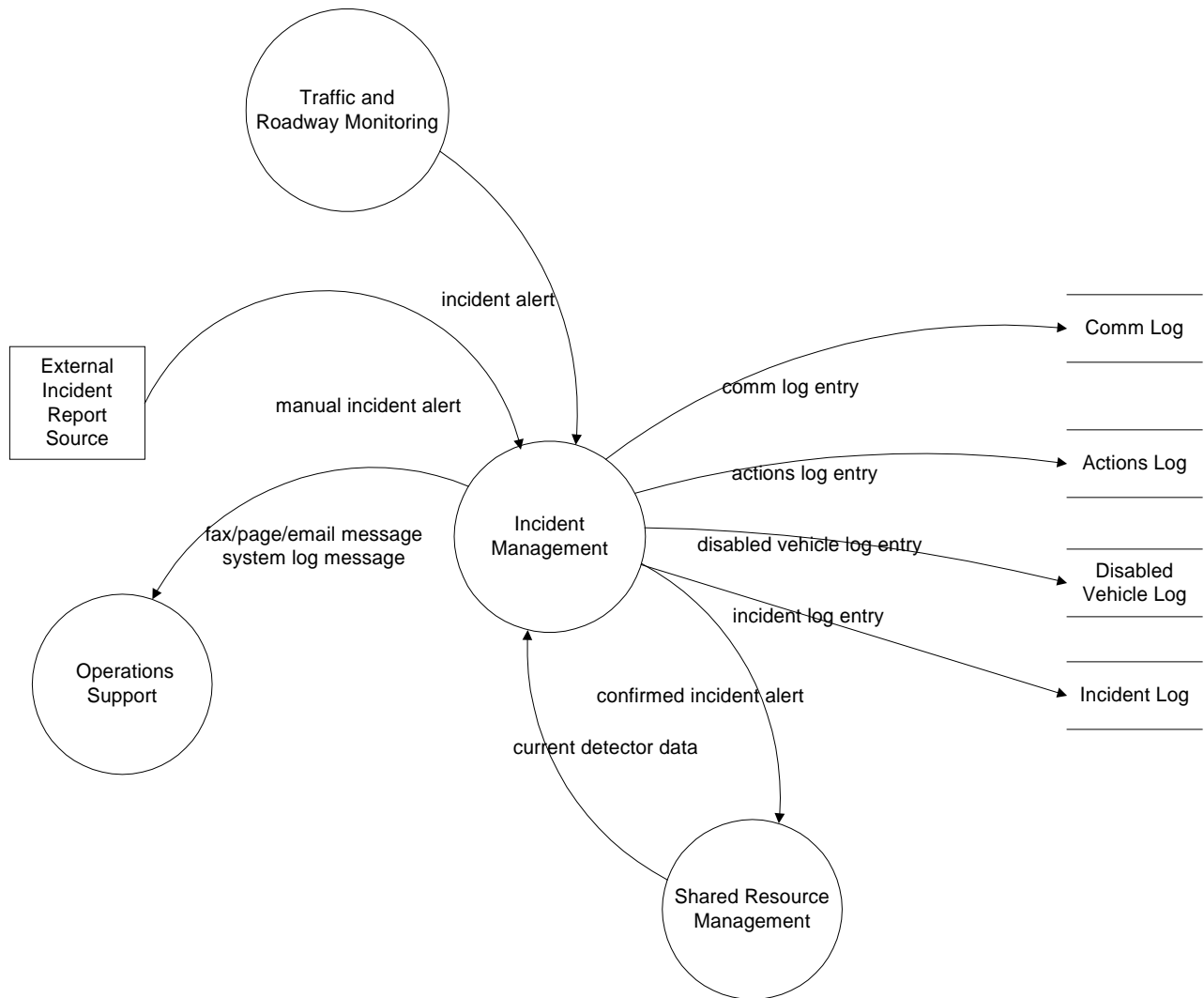
5.2.1.3.3 Shared Resource Management

Description:

This application area communicates with and controls the system's shared devices. It receives and logs information from data collection devices such as speed and loop detectors. As detector data is received the detector history file is updated with summary information. The application area enables control of DMS, HAR, and camera devices and arbitrates their allocation. Cameras are controlled through the AVCM while detector data and communication with DMS and HAR devices is handled via the FMS. The application maintains the DMS and HAR message libraries and the SHA equipment inventory database. The state of the objects are updated as the status of objects such as detectors, DMS, and HAR changes so that the change may be reflected on the map display.

Functions:

- Receive data from roadway detectors.

- Receive device status information.

- Archive sensor data.

- Send commands to reset devices.

- Turn on/off a SHAZAM.

- Maintain DMS and HAR message libraries.

- Post a message to a DMS or HAR.

- Blank a DMS.

- Control a CCTV device.

- Maintain CCTV presets.

- Control/arbitrate shared device allocation.

- Maintain equipment inventory and equipment status.

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Interfaces:

Source/ Target	Interface Type	Description
FMS	App-to-App	Receive device status and detector data. Send device commands, DMS messages, and HAR messages.
AVCM	App-to-App	Send camera commands
Detector Data Archive	Data Store	Archive detector data.
Detector History	Data Store	Create detector history data.
Incident Management	App-to-App	Receive confirmed incident alert.
Traffic and Roadway Monitoring	App-to-App	Receive traffic plan.
Status Display Management	App-to-App	Update objects for display.
Operations Support	App-to-App	Log a system message.
Message Library	Data Store	Update DMS and HAR entries in the message library.
Equipment Inventory	Data Store	Update equipment and equipment status.

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Diagram for Shared Resource Management :
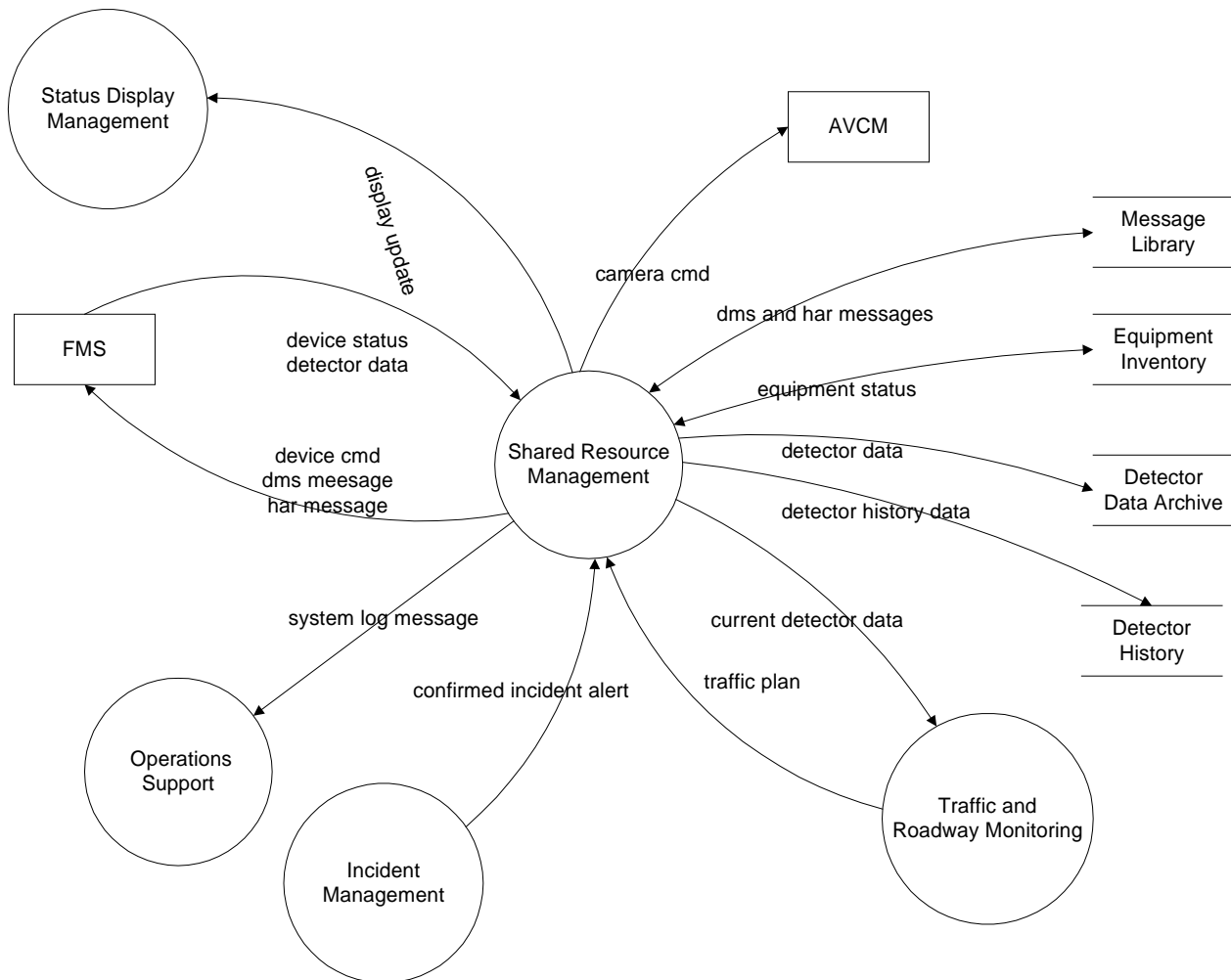
5.2.1.3.4 Status Display Management

Description:

The Status Display Management application area is responsible for updating the main operations display map with the current status of all objects selected for display. As the state of devices, road segments, and other map objects change, the changes are reflected on the display.

Functions:

- Display weather map overlays.

- Update map display with new object states.

Interfaces:

Source/ Target	Interface Type	Description
Web Page	External Agent	Retrieve and display weather map information.
Traffic and Roadway Monitoring	App-to-App	Object status updates.
Operations Support	App-to-App	Object status updates.
Incident Management	App-to-App	Object status updates.
Shared Resource Management	App-to-App	Object status updates.

Diagram for Status Display Management:

Traffic and Roadway Monitoring

display updates

overlay weather map

Web Page

Status Display Management

system log message

display updates

Operations Support

display updates

Incident Management

Shared Resource Management

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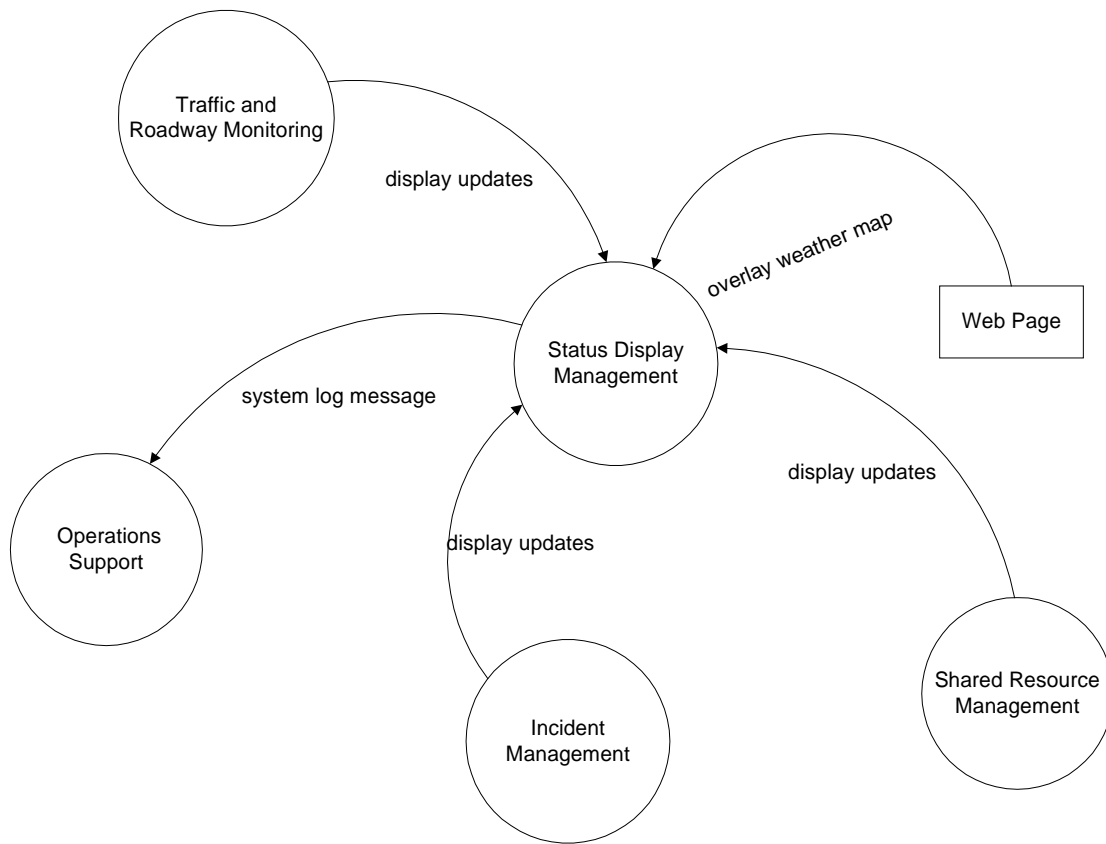
5.2.1.3.5   System Configuration and Administration

Description:

This application area provides those functions required to administer the CHART II system and to maintain the system configuration. It provides functions for adding users to the system and authorizing users to perform specific functions within the system. The application also provides functions for maintaining center information such as the list of centers, the center geographic area of responsibility, and maintenance shop equipment status. It will support the addition and deletion of words from the acceptable and banned words dictionaries.

Functions:

- Maintain users and roles.

- Maintain functional rights.

- Maintain geographic responsibilities.

- Maintain system parameters.

- Maintain links.

- Maintain words dictionary.

- Maintain location navigation data.

- Maintain notification list.

- Maintain plans.

- Maintain scheduled events.

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Interfaces:

Source/ Target	Interface Type	Description
Plans	Data Store	Update to plan library.
Scheduled Events	Data Store	Update to scheduled events list.
Notification list	Data Store	Update to list of recipients for pages, Faxes, and email.
Words dictionary	Data Store	Update to acceptable/banned words dictionary.
Users, Rights, and Functional information	Data Store	Update to user authorization and control.
System parameters	Data Store	Update to system parameters.
Center information	Data Store	Update to center information.
System component and device data	Data Store	Update to component and device configuration.
Operations Support	App-to-App	Log a system message.

Diagram for System Configuration and Administration :

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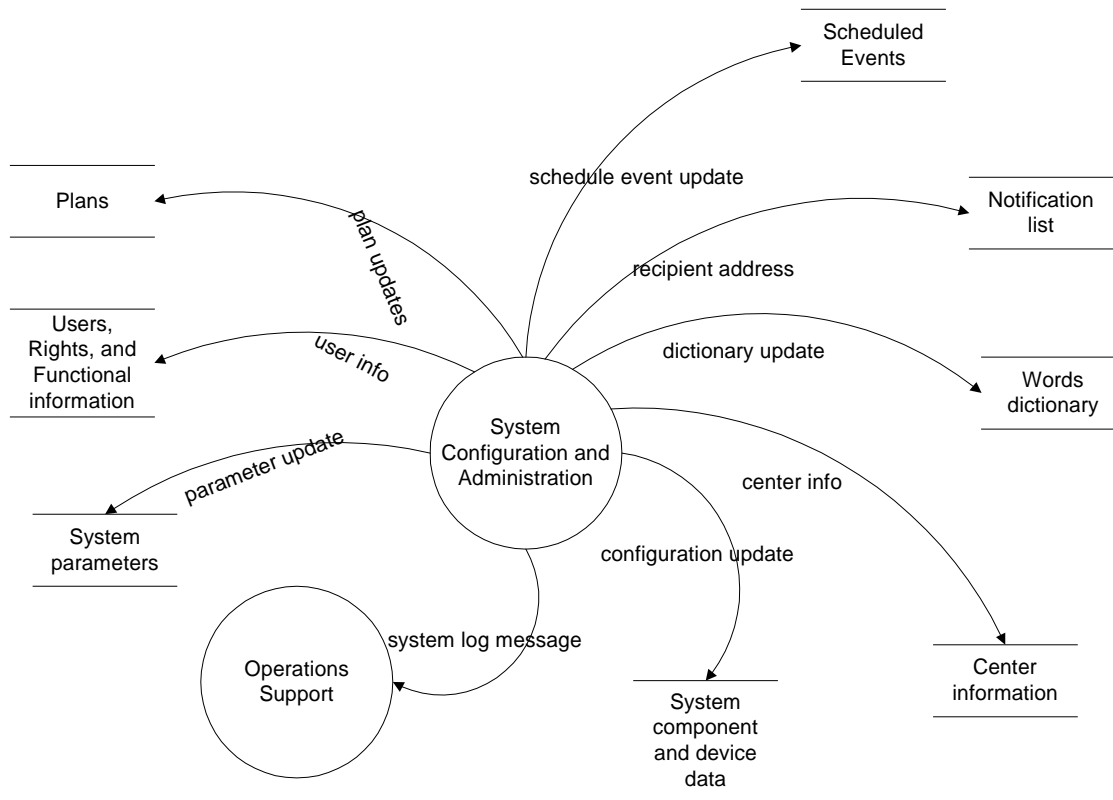
5.2.1.3.6 Operations Support

Description:

The Operations Support application area controls access to the system and provides support to other CHART applications. It provides a system login and logout function to control access to the CHART system. It provides users with the capability to transfer resources currently allocated to them to other users. It also provides a system message logging function to log system status and error messages.

This application area includes two general utility functions, Chat and Notepad. Chat is an operations utility that allows the CHART operators to converse through an online message window. This allows conversations between remote operators without tying up phone lines and without interrupting the operator's ability to listen for audio queues from scanners and other devices. Notepad is another operations utility that provides operators with an online notepad for recording information. Both a personal and a center-wide notepad are supported.

Functions:

- Allows a user to determine which users are logged into the CHART system.

- Allows a user to select another user to exchange text messages with.

- Provides an online personal and center notepad.

- Provide system login/logout.

- Provide transfer of allocated resources to another user.

- Log messages to the Operations log.

Interfaces:

Source/ Target	Interface Type	Description
CHART Operator	External agent	Operators exchange online messages.
Recipient of FAX, page, or email	External agent	Destination of a FAX, page, or email.
Center information	Data Store	Retrieve center information for center responsibilities.
Users, Rights, and Functional information	Data Store	Retrieve user information for authorization and access control.
Notepad	Data Store	View and update center and operator notepad messages data.
Operations log	Data Store	Log system status and error messages.
Incident Management	App-to-App	Receive messages for operations log.
Shared Resource Management	App-to-App	Receive messages for operations log.
Status Display Management	App-to-App	Receive messages for operations log.
Traffic and Roadway Monitoring	App-to-App	Receive messages for operations log.
System Configuration and Administration	App-to-App	Receive messages for operations log.

Diagram for Operations Support:

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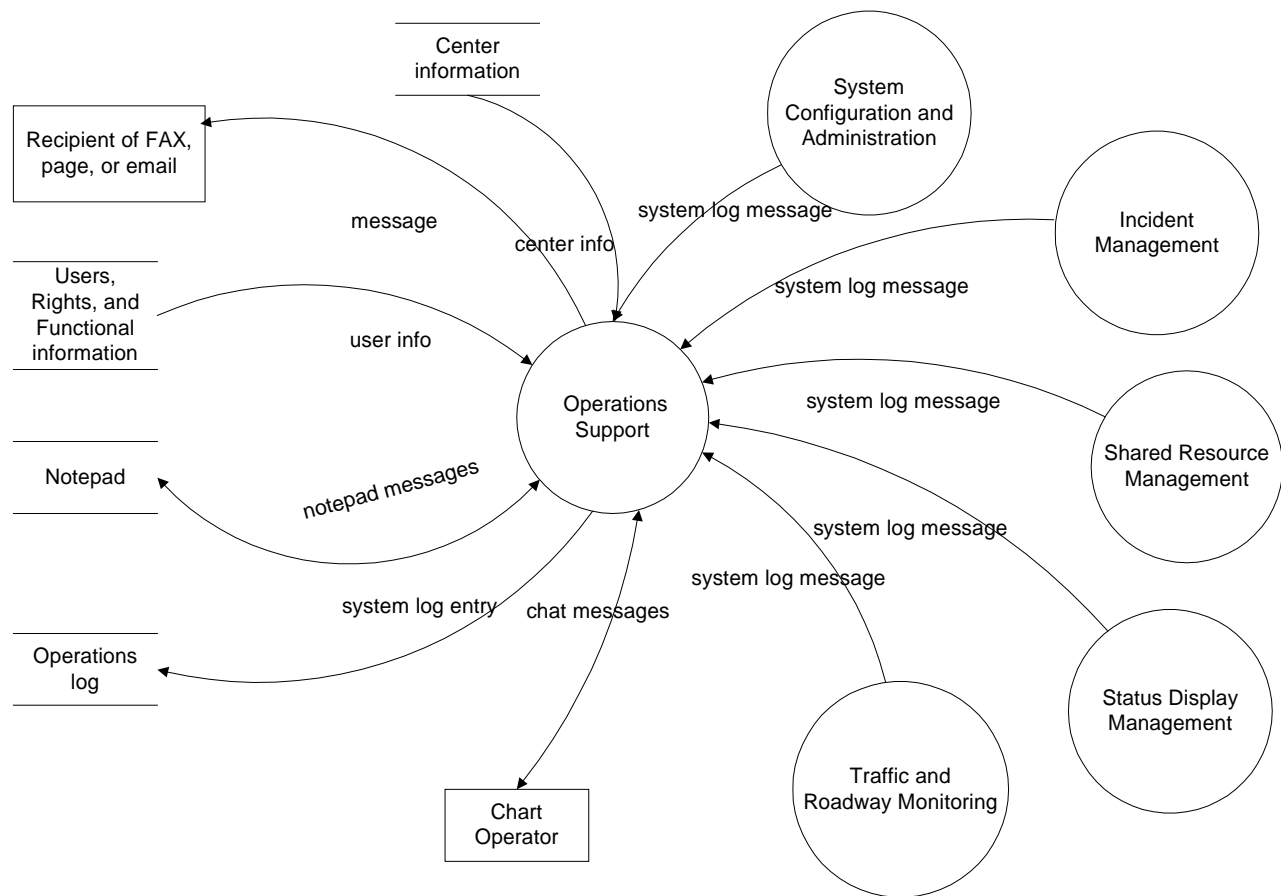
5.2.1.3.7 Report Generation

Description:

This application area supports the generation of reports from the logs. Reports may be displayed online, printed, or saved to a text file.

Functions:

- Generate reports based on time.

- Generate reports based on a specific incident.

Interfaces:

Source/ Target	Interface Type	Description
Operations log	Data Store	Read entries from system log files.

Diagram for Report Generation:
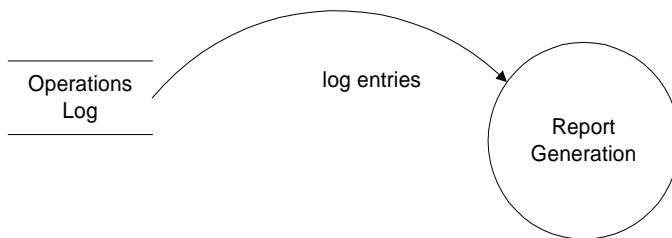
5.2.1.4 COTS Packages

The table below lists the Commercial Off-The-Shelf (COTS) packages or categories of COTS packages that have been identified as candidates for supporting CHART II business processes. In cases where a specific package has been identified, the vendor and package name are given. The *Usage* column describes what the package is to be used for, the *Status* column gives the current status of the package, and the *Supported Processes* column lists those CHART business processes that the package will support. In some cases the COTS package provides general infrastructure support as opposed to supporting specific business processes.

COTS Package	Usage	Status	Supported Processes
SSI, SCAN for Windows	Weather sensor data retrieval	Existing	Handle Weather Sensor Data
Econolite, Traffic Signal Software	Traffic signal status retrieval	Existing	Handle Signal Polling Data
Silverlake Software, Airsource Pro	Paging software	Existing, review required	Perform Notification
Novell, Groupwise Email	Email	Existing, review required	Perform Notification
FAX package	FAX	Existing, review required	Perform Notification
Lernout and Hauspie, RealSpeak	Text to speech conversion	Selected	Maintain HAR Message Library HAR – Add a Message
Seagate, Crystal Reports	Report generation	Proposed	Operational Reports Reports from Archive
AVL package	Automatic vehicle location	Market survey required	Handle AVL Polling Results Perform AVL Function Processing
Object Oriented Concepts, ORBacus	Object request broker, trader services	Selected	General infrastructure support
Sun, Java Help	Online help	Selected	General infrastructure support
Sun, Java JRE	Java Runtime Environment	Selected	General infrastructure support
Oracle	Database management	Selected	General infrastructure support

5.2.2 Process / Application Matrix

The Process/Application Matrix relates the future business processes to the future application areas that support them. It defines, at a conceptual level, the business content of each application. The matrix conveys the following information:

- *Matrix Columns* - The column headings represent the key future application areas.

- *Matrix Rows* - The row titles represent business process threads and are categorized by type of responsibility.

- *Matrix Cells* – An 'x' appearing in a cell indicates that the process is supported by the application area.

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			1	2	3	4	5	6	7
			Traffic and Roadway Monitoring	Incident Management	Report Generation	Status Display Management	Shared Resource Management	System Configuration and Administration	Operations Support
SECURITY AND OPERATIONAL CONTROL									
System Administration									
	a	Maintain Users						X	
	b	Maintain Roles						X	
	c	Maintain Functional Rights						X	
	d	Maintain Functional Responsibilities						X	
	e	Maintain Geographic Responsibility						X	
	f	Maintain Operations Center and AOR						X	
Operational Control									
	a	Maintain Center Notepad							X
	b	User Logon							X
	c	View Center Situation							X
	d	Maintain User Preferences							X
	e	Maintain Operator's Notepad							X
	f	Perform CHART Chat							X
	g	Logout							X
	h	Change User							X
	I	Transfer Resources							X
	j	Respond to Request to Transfer Resources							X
Configuration Processes									
	a	Maintain System Parameters						X	
	b	Maintain Links						X	
FITM Plans									
	a	Maintain FITM Plans						X	
Map Configuration									
	a	Update MDOT GIS Map Data						X	
SYSTEM CONFIGURATION AND STATUS									
Components									
	a	Maintain Component Configuration						X	
	b	Log System Failures							X
Devices									
	a	Maintain Device Configuration						X	
	b	Set Device Online					X		
	c	Set Device Offline					X		
	d	Set Device to Maintenance Mode					X		
	e	Handle DMS and HAR Polling Results					X		
	f	Respond to Device Failure Alerts							X
INCIDENT/EVENT MANAGEMENT									
Logs									
	a	Log Communications Log		X					X
	b	Log Action Log		X			X		
	c	Log Disabled Vehicle Log		X					

Figure 5-3. Process by Application Matrix - Part 1/4

			1	2	3	4	5	6	7
		Operations Support							
		System Configuration and Administration							
		Shared Resource Management							
		Status Display Management							
		Report Generation							
		Incident Management							
		Traffic and Roadway Monitoring							
	d	Log Incident Log		X					
	e	View Historical vs. Current		X					
	f	Log Congestion Log		X					
	g	Log Recurring Congestion Log		X					
	h	Log Special Event Log		X					
	i	Log Weather Advisory Log		X					
	j	Log Weather Sensor Log		X					
	k	Log Safety Message Log		X					
	l	View Log							X
	m	Close Log		X					
Location Navigation									
	a	Maintain Location Navigation Data						X	
	b	Activate Location Navigator		X					
Queues									
	a	Calculate Queue Length		X					
Notification									
	a	Maintain Notification List						X	
	b	Perform Notificaiton							X
SHARED RESOURCE MANAGEMENT									
DMS/HAR Common Processes									
	a	Maintain Acceptable Word Dictionary						X	
	b	Maintain Unacceptable Word Dictionary						X	
	c	Perform Responsibility Reminder					X		
	d	Respond to Responsibility Reminder Alert					X		X
DMS Processes									
	a	Maintain DMS Message Library						X	
	b	DMS – Add a Message					X		
	c	DMS – Remove a Message					X		
	d	DMS – Arbitrate Message Queue					X		
	e	DMS – Evaluate Queue					X		
	f	DMS – Send a Message					X		
	g	DMS – Blank a Sign					X		
	h	DMS - Reset					X		
	i	DMS – Restore Message					X		
	j	DMS- Override Queue					X		
HAR Processes									
	a	Maintain HAR Message Library					X		
	b	HAR – Add a Message					X		
	c	HAR – Remove a Message					X		
	d	HAR – Arbitrate Message Queue					X		
	e	HAR – Evaluate Queue					X		
	f	HAR – Broadcast a Message					X		

Figure 5-4. Process by Application Matrix - Part 2/4

			Traffic and Roadway Monitoring	1	2	3	4	5	6	7
	g		HAR – Broadcast Default Message					X		
	h		HAR – Set Shazam On/Off					X		
	i		HAR – Update Default Message					X		
	j		HAR – Send Maintenance Command					X		
	k		HAR – Restore Message					X		
	l		HAR - Override Queue					X		
AVCM										
	a		Maintain Wall Monitor Configuration					X		
	b		Control Wall Monitor Assignment					X		
	c		Maintain CCTV Presets					X		
	d		Refresh Default AVCM Presets					X		
	e		Maintain Tours					X		
	f		Activate Tour					X		
	g		Control Camera					X		
Detectors										
	a		Handle Polled Detector Data	X				X		
	b		Handle Detector Rules	X				X		
	c		Generate Congestion Response					X		
	d		Respond to Congestion Alert							X
	e		Generate Incident Response					X		
	f		Respond to Incident Alert							X
	g		Activate Response Plan					X		
Equipment										
	a		Maintain Equipment Inventory					X		
	b		Maintain Equipment Status					X		
	c		Alert For Delinquent Equipment Status					X		
	d		Respond to Delinquent Equipment Status Alert							X
Signals										
	a		Handle Signal Polling Data	X				X		
	b		Respond to Exceeded Signal Threshold Alert							X
	c		Download Signal Data					X		
AVL										
	a		Handle AVL Polling Results	X				X		
	b		Perform AVL Function Processing							
	c		Process AVL In/Out of Service Message					X		
	d		Process AVL Mayday Message					X		
	e		Process AVL Arrival On-Scene Message					X		
	f		Process AVL Assist Disabled Vehicle Message					X		
	g		Process AVL Assist Disabled CHART Vehicle Message					X		
	h		Process AVL Available Message					X		
	i		Respond to AVL Alerts							
	j		Respond to Mayday Alert from AVL							X
	k		Respond to Arrival On-Scene Alert from AVL							X

Column headers (diagonal labels):
1. Traffic and Roadway Monitoring
2. Incident Management
3. Report Generation
4. Status Display Management
5. Shared Resource Management
6. System Configuration and Administration
7. Operations Support

Figure 5-5. Process by Application Matrix - Part 3/4

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			Traffic and Roadway Monitoring	Incident Management	Report Generation	Status Display Management	Shared Resource Management	System Configuration and Administration	Operations Support
			1	2	3	4	5	6	7
	l		Respond to Disabled Vehicle Alert from AVL						X
ALERTS									
	a		Send Manual Alert	X					
	b		Send Alert	X					
	c		Escalate Alert	X					
PLANS									
	a		Maintain Plans						X	
	b		Activate Plan		X			X		
	c		Deactivate Plan		X			X		
SCHEDULED EVENTS									
	a		Maintain Scheduled Events						X	
	b		Process Scheduled Events Start	X				X		
	c		Process Scheduled Events End	X				X		
EORS INTERFACE									
	Construction								
	a		Download EORS Permits	X					
	b		Activate EORS Icon On Map				X		
	c		Activate EOR Permit	X					
	Snow Emergency								
	a		Maintain Snow Emergency Declaration	X					
	Phone Book								
	a		Access Phone Book							X
WEATHER SUPPORT									
	National Weather Service								
	a		View National Weather Service Data				X		
	b		Process Weather Alerts From The NWS	X					
	c		Respond to National Weather Service Alert							X
	d		Fax Weather Report	X					
	SCAN								
	a		Handle Weather Sensor Data	X					
	b		Generate Weather Sensor Response	X					
	c		Respond to Weather Sensor Alert	X					
ARCHIVING AND REPORTS									
	Archiving								
	a		Archive Update - Add							X
	b		Archive Update - Update Log Data							X
	c		Real Time System Update - Delete							X
	Reports								
	a		Operational Reports			X			
	b		Reports from Archive			X			

Figure 5-6. Process by Application Matrix - Part 4/4

6 Data Model Views

This section presents various model views of the Data domain of change as derived from CHART II visioning and process design workshops. The Direction Model provides the principles, constraints and assumptions that guide the design of data stores. The Conceptual Model provides the identification and definition of conceptual entities identified in the business processes, and Process-to-Entity matrices summarizing the usage of entities within the business processes.

6.1 Data Direction Model

This model shows what application principles, constraints, and assumptions impact the project.

6.1.1 Data Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The table below shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶   Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷   To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸   Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	Single entry of data
❶	Near real time distribution of incident, device, and system status
❶	System must retrieve and distribute legacy data
❶	System must provide the ability to widely distribute raw data from archive off-line
❶	Data will be validated at the time of data entry
❶	Data will be configured to support pre-defined and ad-hoc reporting
❶	System must log all operator actions in the system
❶	System must leverage/share all incident information with CHART partners
❶	All data from a device may be stored

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❶	Data will be imported/exported to CHART partners (other agencies)
❶	Data will be TMDD compliant
❸	The system will provide the capability to configure data logging (on/off)
❸	The system will provide the capability to configure data import (on/off)
❶	The system will allow event driven configuration overrides
❶	The system will have the ability to configure device data recording (times or conditions)
Constraints	
	None
Assumptions	
❶	Sensor data is assumed to be valid

6.2 Conceptual Data Model

The data model views for CHART II include a conceptual entity relationship diagram depicting major data entities and their relationships with one another, a table of Entity Definitions, and a Process/Entity Matrix identifying which entities are utilized in each process.

6.2.1 Entity Relationship Diagram

The Entity Relationship Diagram (ERD) depicts the data entities referred to in the business process model data flow diagrams and identifies the relationships between the entities. The following two figures present the ERD from the BusinessTeam modeling tool.

CHART II Business Area Architecture Report   306   August 23, 2000
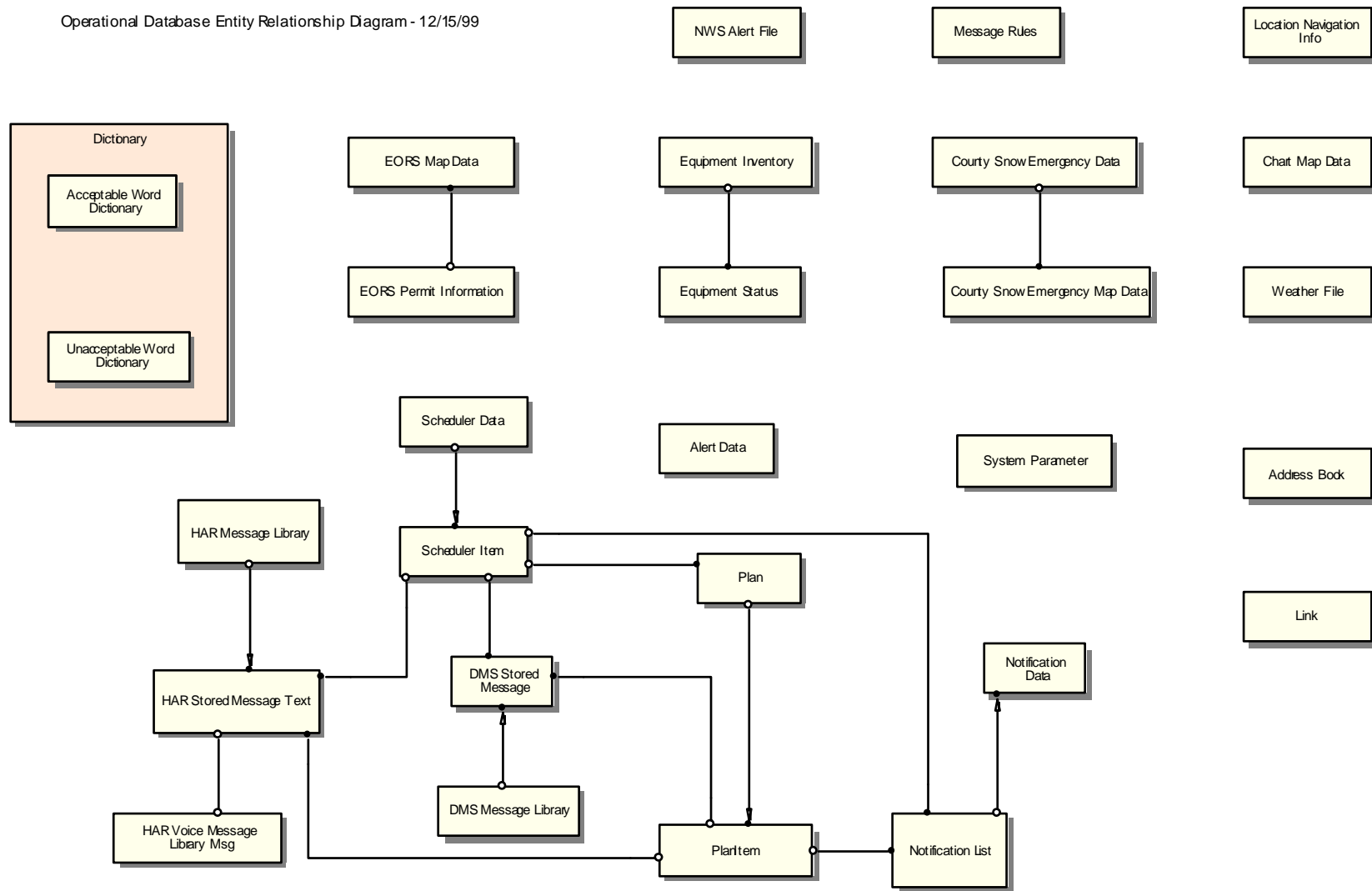
Figure 6-1. Conceptual Entity Relationship Diagram, Part 1/3

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Operational Database Entity Relationship Diagram - 12/10/99
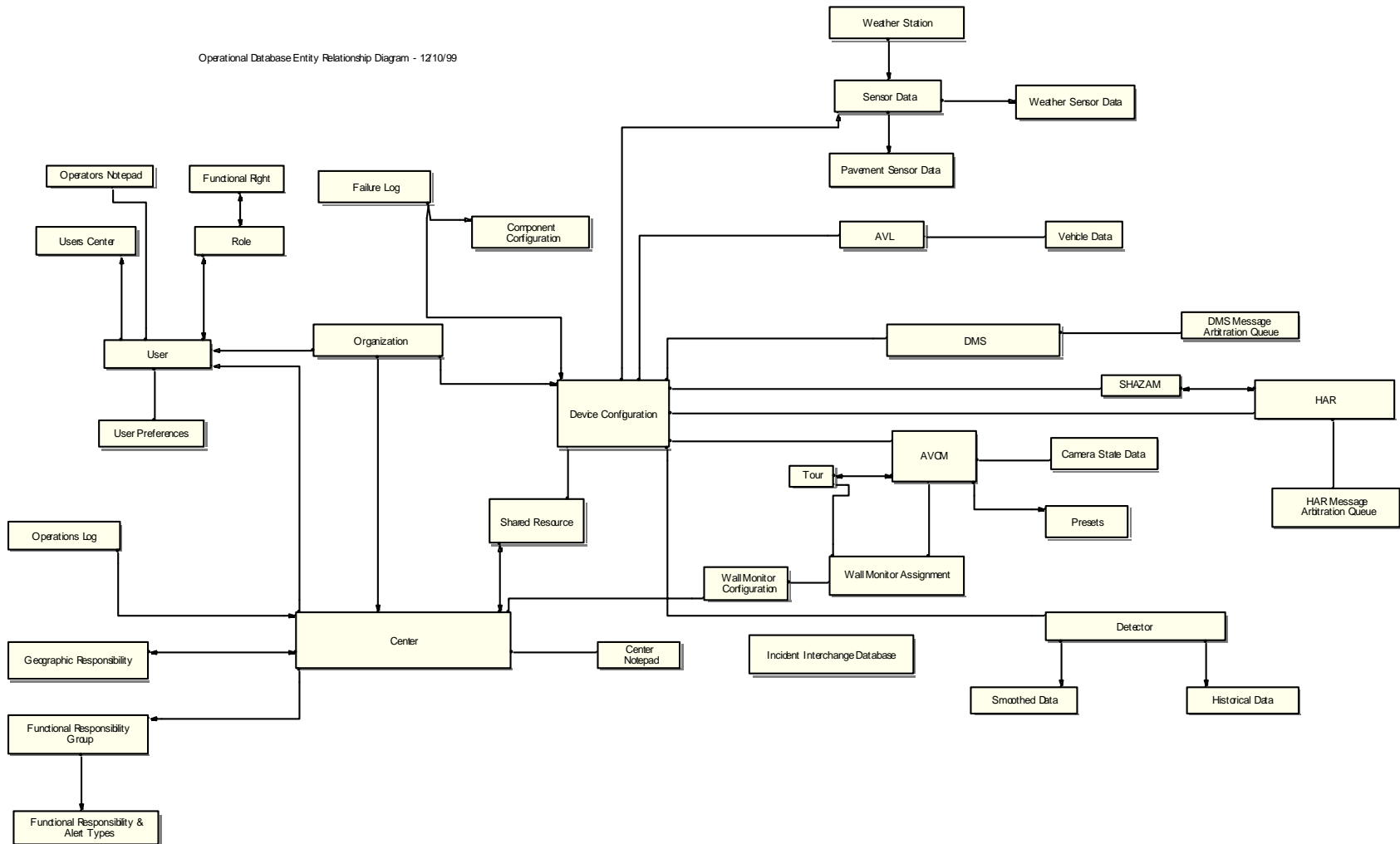
Figure 6-2. Conceptual Entity Relationship Diagram, Part 2/3
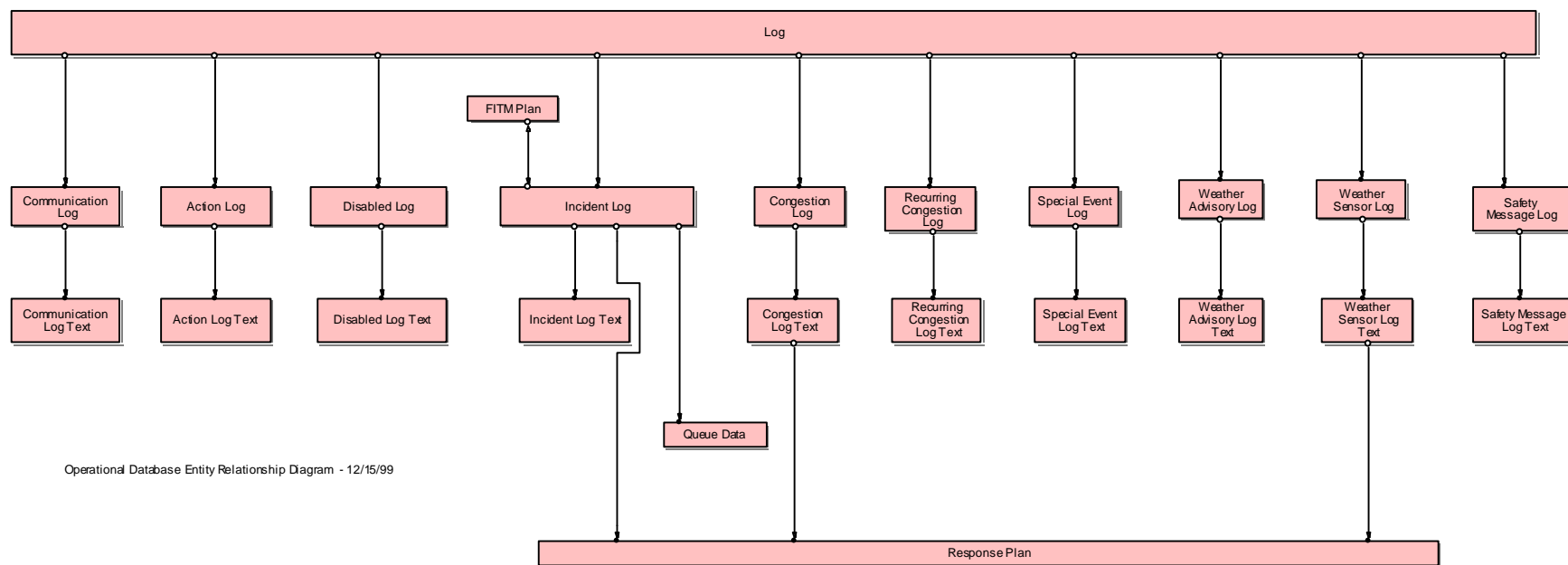
Operational Database Entity Relationship Diagram - 12/15/99

Each Response Plan can be associated with Notification
and Stored Messages for both HAR and DMS.

Figure 6-3. Conceptual Entity Relationship Diagram, Part 3/3

6.2.2 Entity Definitions

The following tables give a brief description of each of the Entities identified in the Entity Relationship Diagram.

Table 6-1. Entity Definitions

Entity	Description
Acceptable Word Dictionary	List of words and phrases considered acceptable as a part of a message to be displayed on a device.
Action Log	Information related to the disposition of the actions related to device failures and non-blockage events (*i.e.,* signals, debris, utility, signs).
Action Log Text	Text entry to identify action taken in relation to specific action log.
Address Book	Names, work-related phone numbers, e-mail addresses, and pager numbers of CHART related personnel.
Alert Data	Information related to each alert sent in the system.
Archive	A separate database that contains a collection of real-time database information for reporting and simulation.
AVCM	Configuration information identifying camera devices used to monitor roadways.
AVL	Configuration information for automated vehicle location (AVL) devices, as well as information related to actions of each AVL device.
Camera State Data	Information on each camera that captures what the current position of the camera is when it is being controlled, and what the default state should be so the camera can be returned to its default state, once control is relinquished. Information would include: camera ID, camera name, preset ID, preset name, and positioning (*i.e.,* pan/tilt/zoom positions).
Center	Configuration information that is required to define an operation center with associated functional responsibilities and a geographic area. Data may include center name, center ID, alert types, functional responsibility groups, and location.
Center Notepad	Free-form text data for each center. Data may include center name, center ID, and free text.
Chart Map Data	Data required for displaying all map layers.
Communications Log	Data received from any source that requires no further action. Information may include receiving operator ID, source, and method of communication.
Communications Log Text	Text entry to identify action taken in relation to specific communication log.
Component Configuration	Contains data needed to identify system components. Information may include polling frequency,

Entity	Description
	error checks, and component correction data.
Congestion Log	Information received from the system and outside sources relating to congestion situations. Will include source data (detector and operator), the tracking of all shared resources used associated with the log, and notifications made.
Congestion Log Text	Text entry to identify action taken in relation to specific congestion log.
County Snow Emergency Data	Contains data pertaining to each instance of a declared county snow emergency. This includes all data received from the EORS system.
County Snow Emergency Map Data	Contains data for display of a county snow emergency on the map.
Detector	Configuration data for a detector including location, type, and polling frequency.
Device Configuration	Superset of all device type configuration data.
Disabled Log	Information related to a single instance of providing assistance to a disabled vehicle. Data includes vehicle identification, data/time, ETP/ERU unit providing assistance, and location.
Disabled Log Text	Text entry to identify action taken in relation to specific disabled vehicle log.
DMS	Configuration information relative to a dynamic message sign (DMS), including location and communications information.
DMS Message Arbitration Queue	Queue data for each DMS device. Each queue contains priority levels, and when being used the information pertaining to the message such as text and associated Log ID. Each priority may have multiple messages or slots.
DMS Message Library	Multiple topic-oriented libraries, each containing information defining each DMS stored message including the message name, type/sub-type, and beacon state of each stored message.
DMS Stored Message	Message text associated with each stored message listed in the DMS Message Library.
EORS Map Data	All information required for the proper display of roadwork icons on the map. This data may include icon type, color, location, and map layer
EORS Permit Information	Permit data downloaded from the EORS database. This data may include permit ID, construction company information, general location and type of construction. Each permit may have multiple schedule entries, which include specific location, start date/time, end date/time, and lane closures.
Equipment Inventory	Number and type of equipment used by the Maryland State Highway Administration's shops in assisting with CHART II related actions. The data is organized by shop and would show the types of equipment and the respective quantities.
Equipment Status	Status information relating to the inventory. Data to include equipment type, total quantity in the shop, quantity available for use, and quantity of equipment that is not available.

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Entity	Description
Failure Log	Information related to each detected instance of hardware or component failure. Data may include device ID, date/time stamp, and failure code. Exact failure data returned from a device during polling may be stored.
FITM Plan	Information related to a FITM response plan. Will include: scanned images, response text, and map data.
Functional Responsibility and Alert Types	Table of functional responsibilities and alert types that may be assigned to the operational centers (either directly or through functional responsibility groups)
Functional Responsibility Group	Groups of functional responsibilities and alert types. Included would be names of groups, and links to related functional responsibility and alert type.
Functional Right	Table of functional capabilities allowed for operators of the system. Included are: functional rights name and ID.
Functional Rights Group	Shows groups of functional rights. Included would be names of groups, and ID.
Geographic Responsibility	Data used to define a geographical area. Geographic boundaries used to designate the geographic areas of responsibility for the operational centers.
HAR	Contains configuration data to define Highway Advisory Radio (HAR) device.
HAR Message Arbitration Queue	Queue data for each HAR device. Included are: priority level of message, log to which the message is associated, the associated message to be broadcast, and the status of whether the entry is currently being broadcast or not.
HAR Message Library	Contains listing of all messages that have been developed for each HAR device, whether for message text or voice. Messages will have an associated ID.
HAR Stored Message Text	All text associated with each stored message in the HAR Message Library. Each message will have header, body, and footer information.
HAR Voice Message	All voice (WAV) files for each voice message in the HAR Message Library.
Historical Data	Normal traffic flow data for a given detector keyed on type of day, day of week, time of day (15 minute increments), pavement conditions/weather conditions. Each instance will contain volume, occupancy, and speed.
Incident Interchange	A separate database that will have a subset of data for incidents. Information to be stored will be incident ID information, such as: location, lane closure information, type of incident, queue length, and estimated clear time. There will be no text entries from the incident logs.
Incident Log	Data received relating to each incident captured in the system. Information will include source of data, status, location, type of incident, Each tracked item will include appropriate date/time

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Entity	Description
	stamps for performance measurement calculations.
Incident Log Text	Text entry to identify action taken in relation to the specific incident log.
Link	Relationships of specific detectors to the CHART map data. The relation to CHART map data is necessary to specify where each link is to be displayed on the map. (Specific definition of a Link is undefined.)
Location Navigation Info	Map coordinates for landmarks, exits, intersections, etc. for each highway, for pinpointing location of activity to be recorded in the appropriate Log.
Log	Highest level of information of all logs in the system. Mainly log ID, type, start/end date and time.
Message Rules	Data necessary for the system to generate a response plan for automatic detection of congestion, incident, and bad weather. Types of data may include log (situation) type, area of coverage (distance from detector), type of devices, and generic message format.
Notification Data	All information for individuals listed for notification. Types of data included would be group name, individual name, notification method, and all associated contact data (*i.e.,* pager number, e-mail address, fax number).
Notification List	List of all individual listed by function, notification individual, notification group.
NWS Alert File	Alert data related to a National Weather Service alert.
Operations Log	Information related to all actions taken by individuals within the system. Mostly used as an audit trail to keep track of changes. Data to include UserID, date/time, function performed, and related functional data.
Operators Notepad	Free-form text of information stored by each individual in the system.
Organization	Data to define what shared resources are owned by which group of the organization.
Pavement/Weather Sensor Data	Data received from pavement and weather sensor polling of each device. Information could include temperature, moisture, and content for pavement sensors, and temperature, wind speed, fog, etc. for weather sensors.
Plan	Identification information defining a plan in the system. Included data items will be Plan ID, name, and type.
Plan Item	Individual command line of a plan. Data may include Plan ID, function identifier, and specific data items to perform the function.
Presets	Pre-determined pan/tilt/zoom specifications for AVCM cameras. Information would include: preset ID, preset name, and positioning (*i.e.,* pan/tilt/zoom positions).

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Entity	Description
Queue Data	Subset of incident log information. Information taken from sensors or entered by an operator to record the estimated queue (backup) length of traffic in one or more directions in relation to an incident. Data may include Log ID, direction, and queue length, date/time. Any one incident log may have multiple sets of queue data over the duration of the incident.
Recurring Congestion Log	Information received from the system and outside sources related to recurring congestion situations. Will include source data (detector and operator), the tracking of all shared resources used associated with the log, and notifications made.
Recurring Congestion Log Text	Contains the individual lines of free form or system-generated text describing the actions taken related to each recurring congestion log.
Response Plan	Data contained in a system-generated response to a detected instance of congestion, instance or poor weather conditions. Would include message text and identity of DMS or HAR to display/broadcast the message.
Role	Values designating the various security roles defined. Maintains the relation to the set of Functional Rights identifying the system capabilities associated with each Role.
Safety Message Log	Information pertaining to the display and/or broadcast of safety messages. All shared resources used are logged.
Safety Message Log Text	Contains the individual lines of free form or system-generated text related to each safety message log.
Scheduler Data	Header information related to events in the scheduler. Data would include ID and name of scheduled event, start and end times, and any other associated header data.
Scheduler Item	The detailed information for each action to be taken when the scheduled event is initiated. Data will include Scheduler Data ID, action code, parameter data related to the action code.
Sensor Data	Information retrieved from the SCAN database that provides pavement sensor data. Data could include temperature, moisture, and content for pavement sensor (*hockey pucks*).
SHAZAM	Configuration data to identify a SHAZAM and its relation with one or more HAR devices. Also, since a DMS could act as a SHAZAM, information relating to this would also be stored.
Signal	Sub-type of device configuration. Configuration information to identify each signal device.
Smoothed Data	Detector data averaged over the polling period.
Special Event Log	Information received from the system and outside sources relating to a special event. Will include source data (scheduled plan and operator), location, and start/end times.
Special Event Log Text	Contains the individual lines of free form or system-generated text related to tracking of all

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Entity	Description
	shared resources used that are associated with the log and any notifications made for each special event log.
System Parameters	Data used to control the processes in the CHART II system.
Tour	Data related to displaying a sequence of camera images on a monitor, wall, media feeds, or web feeds.
Unacceptable Word Dictionary	List of words and phrases considered unacceptable as a part of a message to be displayed on a device.
User	Configuration data as it relates to each authorized CHART II user. Data may include user name, ID, authorization password, and links to one or more role(s).
User Preferences	Data defining each individual user's interface preferences.
Users Center	Links between User and Center to define which centers the user is authorized to represent. Each user may be assigned to one or more centers.
Vehicle Data	Polled or received data on vehicles equipped with AVL. Information stored may be time stamp, location, speed, operator call sign, and status.
Wall Monitor Assignment	Linkage data relating a video feed to a specific wall monitor to control which cameras are being displayed on which wall monitors. Information may link a single camera or a tour to a wall monitor.
Wall Monitor Configuration	Configuration information needed to identify a wall monitor to accept display camera and tour data.
Weather Advisory Log	Information received from the system and outside sources relating to National Weather Service advisories. Will include source data, weather conditions, location, start/end time.
Weather Advisory Log Text	Contains the free form or system-generated text related to tracking of all shared resources used, notifications made, and disposition data for each weather advisory log.
Weather File	NWS weather report that is stored on the SHA web page.
Weather Sensor Log	Information received from the system and outside sources relating to a weather sensor alert. Will include location of sensor and sensor data causing the alert.
Weather Sensor Log Text	Contains the free-form or system generated text related to returned, tracking of all shared resources used, notifications made, and other actions taken in relation to each weather sensor log.
Weather Station	Configuration information needed to identify a weather station for use on the CHART II system. Information would include location, communications protocol, and polling frequency.

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6.2.3 Process/Entity Matrix

The Process/Entity Matrix provides a cross-reference of business processes and data entities, identifying which entities are referenced in which processes. The intersection of Processes and Entity indicates the action performed on the Entity by the Process. These actions are expressed with the following codes:

- C = Create
- R = Read
- U = Update
- D = Delete

The following figures present this matrix.

Process	Acceptable Word Dictionary	Action Log	Action Log Text	Address Book	Alert Data	Archive	AVCM	AVL	Camera State Data	Center	Center Notepad	Chart Map Data	Communication Log	Communication Log Text	Component Configuration	Congestion Log	Congestion Log Text	County Snow Emergency Data
SECURITY AND OPERATIONAL CONTROL																		
System Administration																		
a Maintain Users										R								
b Maintain Roles																		
c Maintain Functional Rights																		
d Maintain Functional Responsibilities										R								
e Maintain Geographic Responsibility										R								
f Maintain Center and AOR										CRUD								
Operational Control																		
a Maintain Center Notepad											CRUD							
b User Logon										R								
c View Center Situation		R			R						R							
d Maintain User Preferences																		
e Maintain Operator's Notepad																		
f Perform CHART Chat																		
g Logout																		
h Change User																		
i Transfer Resources					C													
j Respond to Request to Transfer Resources					CR													
Configuration Processes																		
a Maintain System Parameters																		
b Maintain Links																		
FITM Plans																		
a Maintain FITM Plans																		
Map Configuration																		
a Update MDOT GIS Map Data												CUD						
SYSTEM CONFIGURATION AND STATUS																		
Components																		
a Maintain Component Configuration															CRUD			
b Log System Failures					C										R			
Devices																		
a Maintain Device Configuration																		
b Set Device Online																		
c Set Device Offline																		
d Set Device to Maintenance Mode																		
e Handle DMS and HAR Polling Results					C													
f Respond to Device Failure Alerts		CR			CRU													
INCIDENT/EVENT MANAGEMENT																		
Logs																		
a Log Communications Log													CR	C				
b Log Action Log		CR	C		C													
c Log Disabled Vehicle Log																		

Figure 6-4. Process/Entity Matrix, Part 1/20

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			County Snow Emergency Map Data	Detector	Device Configuration	Disabled Log	Disabled Log Text	DMS	DMS Message Arbitration Queue	DMS Message Library	DMS Stored Message	EORS Map Data	EORS Permit Information	Equipment Inventory	Equipment Status	Failure Log	FITM Plan	Functional Responsibility and Alert Types	Functional Responsibility Group	Functional Right
SECURITY AND OPERATIONAL CONTROL																				
System Administration																				
	a	Maintain Users																		
	b	Maintain Roles																		
	c	Maintain Functional Rights																		**CRUD**
	d	Maintain Functional Responsibilities																**CRUD**	**CRUD**	
	e	Maintain Geographic Responsibility																		
	f	Maintain Center and AOR																**R**		
Operational Control																				
	a	Maintain Center Notepad																		
	b	User Logon																	**R**	**R**
	c	View Center Situation														**R**				
	d	Maintain User Preferences																		
	e	Maintain Operator's Notepad																		
	f	Perform CHART Chat																		
	g	Logout																		
	h	Change User																		
	i	Transfer Resources																		
	j	Respond to Request to Transfer Resources																		
Configuration Processes																				
	a	Maintain System Parameters																		
	b	Maintain Links			**R**															
FITM Plans																				
	a	Maintain FITM Plans															**CRUD**			
Map Configuration																				
	a	Update MDOT GIS Map Data																		
SYSTEM CONFIGURATION AND STATUS																				
Components																				
	a	Maintain Component Configuration																		
	b	Log System Failures														**C**				
Devices																				
	a	Maintain Device Configuration			**CRUD**															
	b	Set Device Online			**R**															
	c	Set Device Offline			**R**															
	d	Set Device to Maintenance Mode			**R**															
	e	Handle DMS and HAR Polling Results						**CRU**								**C**				
	f	Respond to Device Failure Alerts																		
INCIDENT/EVENT MANAGEMENT																				
Logs																				
	a	Log Communications Log																		
	b	Log Action Log																		
	c	Log Disabled Vehicle Log				**CR**	**CR**													

Figure 6-5. Process/Entity Matrix, Part 2/20

	Functional Rights Group	Geographic Responsibility	HAR	HAR Message Arbitration Queue	HAR Message Library	HAR Stored Message Text	HAR Voice Message	Historical Data	Incident Interchange	Incident Log	Incident Log Text	Link	Location Navigation Info	Log	Message Rules	Notification Data	Notification List	NWS Alert File
SECURITY AND OPERATIONAL CONTROL																		
System Administration																		
a Maintain Users																		
b Maintain Roles																		
c Maintain Functional Rights	**CRUD**																	
d Maintain Functional Responsibilities																		
e Maintain Geographic Responsibility		**CRUD**																
f Maintain Center and AOR		**R**																
Operational Control																		
a Maintain Center Notepad																		
b User Logon																		
c View Center Situation										**R**								
d Maintain User Preferences																		
e Maintain Operator's Notepad																		
f Perform CHART Chat																		
g Logout																		
h Change User																		
i Transfer Resources																		
j Respond to Request to Transfer Resources																		
Configuration Processes																		
a Maintain System Parameters																		
b Maintain Links												**CRUD**						
FITM Plans																		
a Maintain FITM Plans																		
Map Configuration																		
a Update MDOT GIS Map Data																		
SYSTEM CONFIGURATION AND STATUS																		
Components																		
a Maintain Component Configuration																		
b Log System Failures																		
Devices																		
a Maintain Device Configuration																		
b Set Device Online																		
c Set Device Offline																		
d Set Device to Maintenance Mode																		
e Handle DMS and HAR Polling Results			**CRU**															
f Respond to Device Failure Alerts																		
INCIDENT/EVENT MANAGEMENT																		
Logs																		
a Log Communications Log																		
b Log Action Log																		
c Log Disabled Vehicle Log																		

Figure 6-6. Process/Entity Matrix, Part 3/20

			Process	Operations Log	Operators Notepad	Organization	Pavement/Weather Sensor Data	Plan	Plan Item	Presets	Queue Data	Recurring Congestion Log	Recurring Congestion Log Text	Response Plan	Role	Safety Message Log	Safety Message Log Text	Scheduler Data	Scheduler Item	Sensor Data	SHAZAM
SECURITY AND OPERATIONAL CONTROL																					
	System Administration																				
		a	Maintain Users	C											R						
		b	Maintain Roles	C											CRUD						
		c	Maintain Functional Rights	C											R						
		d	Maintain Functional Responsibilities	C																	
		e	Maintain Geographic Responsibility	C																	
		f	Maintain Center and AOR	C																	
	Operational Control																				
		a	Maintain Center Notepad	C																	
		b	User Logon	C											R						
		c	View Center Situation																		
		d	Maintain User Preferences																		
		e	Maintain Operator's Notepad	C	CRUD																
		f	Perform CHART Chat																		
		g	Logout	C																	
		h	Change User																		
		i	Transfer Resources	C																	
		j	Respond to Request to Transfer Resources																		
	Configuration Processes																				
		a	Maintain System Parameters	C																	
		b	Maintain Links	C																	
	FITM Plans																				
		a	Maintain FITM Plans	C																	
	Map Configuration																				
		a	Update MDOT GIS Map Data																		
SYSTEM CONFIGURATION AND STATUS																					
	Components																				
		a	Maintain Component Configuration	C																	
		b	Log System Failures																		
	Devices																				
		a	Maintain Device Configuration	C			RD											RD			
		b	Set Device Online	C																	
		c	Set Device Offline	C																	
		d	Set Device to Maintenance Mode	C																	
		e	Handle DMS and HAR Polling Results																		
		f	Respond to Device Failure Alerts																		
INCIDENT/EVENT MANAGEMENT																					
	Logs																				
		a	Log Communications Log																		
		b	Log Action Log																		
		c	Log Disabled Vehicle Log																		

Figure 6-7. Process/Entity Matrix, Part 4/20

				Signal	Smoothed Data	Special Event Log	Special Event Log Text	System Parameters	Tour	Unacceptable Word Dictionary	User	User Preferences	Users Center	Vehicle Data	Wall Monitor Assignment	Wall Monitor Configuration	Weather Advisory Log	Weather Advisory Log Text	Weather File	Weather Sensor Log	Weather Sensor Log Text	Weather Station
SECURITY AND OPERATIONAL CONTROL																						
System Administration																						
	a		Maintain Users								CRUD											
	b		Maintain Roles																			
	c		Maintain Functional Rights																			
	d		Maintain Functional Responsibilities																			
	e		Maintain Geographic Responsibility																			
	f		Maintain Center and AOR																			
Operational Control																						
	a		Maintain Center Notepad																			
	b		User Logon								R	R										
	c		View Center Situation					R														
	d		Maintain User Preferences									CRUD										
	e		Maintain Operator's Notepad								R											
	f		Perform CHART Chat																			
	g		Logout																			
	h		Change User																			
	i		Transfer Resources																			
	j		Respond to Request to Transfer Resources																			
Configuration Processes																						
	a		Maintain System Parameters					CRUD														
	b		Maintain Links																			
FITM Plans																						
	a		Maintain FITM Plans																			
Map Configuration																						
	a		Update MDOT GIS Map Data																			
SYSTEM CONFIGURATION AND STATUS																						
Components																						
	a		Maintain Component Configuration																			
	b		Log System Failures					R														
Devices																						
	a		Maintain Device Configuration																			
	b		Set Device Online																			
	c		Set Device Offline																			
	d		Set Device to Maintenance Mode																			
	e		Handle DMS and HAR Polling Results																			
	f		Respond to Device Failure Alerts																			
INCIDENT/EVENT MANAGEMENT																						
Logs																						
	a		Log Communications Log																			
	b		Log Action Log																			
	c		Log Disabled Vehicle Log																			

Figure 6-8. Process/Entity Matrix, Part 5/20

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			Acceptable Word Dictionary	Action Log	Action Log Text	Address Book	Alert Data	Archive	AVCM	AVL	Camera State Data	Center	Center Notepad	Chart Map Data	Communication Log	Communication Log Text	Component Configuration	Congestion Log	Congestion Log Text	County Snow Emergency Data
	d	Log Incident Log					C													
	e	View Historical vs. Current																		
	f	Log Congestion Log					C											CR	C	
	g	Log Recurring Congestion Log																		
	h	Log Special Event Log					C													
	i	Log Weather Advisory Log					C													
	j	Log Weather Sensor Log					C													
	k	Log Safety Message Log																		
	l	View Log																		
	m	Close Log																		
Location Navigation																				
	a	Maintain Location Navigation Data																		
	b	Activate Location Navigator																		
Queues																				
	a	Calculate Queue Length																		
Notification																				
	a	Maintain Notification List																		
	b	Perform Notification																		
SHARED RESOURCE MANAGEMENT																				
DMS/HAR Common Processes																				
	a	Maintain Acceptable Word Dictionary	CRUD																	
	b	Maintain Unacceptable Word Dictionary																		
	c	Perform Responsibility Reminder					C													
	d	Respond to Responsibility Reminder Alert					CR													
DMS Processes																				
	a	Maintain DMS Message Library	R																	
	b	DMS – Add a Message	R																	
	c	DMS – Remove a Message																		
	d	DMS – Arbitrate Message Queue																		
	e	DMS – Evaluate Queue																		
	f	DMS – Send a Message																		
	g	DMS – Blank a Sign																		
	h	DMS - Reset																		
	i	DMS – Restore Message																		
	j	DMS- Override Queue																		
HAR Processes																				
	a	Maintain HAR Message Library	R																	
	b	HAR – Add a Message	R																	
	c	HAR – Remove a Message																		
	d	HAR – Arbitrate Message Queue																		
	e	HAR – Evaluate Queue																		
	f	HAR – Broadcast a Message																		

Figure 6-9. Process/Entity Matrix, Part 6/20

		County Snow Emergency Map Data	Detector	Device Configuration	Disabled Log	Disabled Log Text	DMS	DMS Message Arbitration Queue	DMS Message Library	DMS Stored Message	EORS Map Data	EORS Permit Information	Equipment Inventory	Equipment Status	Failure Log	FITM Plan	Functional Responsibility and Alert Types	Functional Responsibility Group	Functional Right
d	Log Incident Log															R			
e	View Historical vs. Current			R															
f	Log Congestion Log		R																
g	Log Recurring Congestion Log																		
h	Log Special Event Log																		
i	Log Weather Advisory Log																		
j	Log Weather Sensor Log																		
k	Log Safety Message Log																		
l	View Log																		
m	Close Log		U																
Location Navigation																			
a	Maintain Location Navigation Data																		
b	Activate Location Navigator																		
Queues																			
a	Calculate Queue Length																		
Notification																			
a	Maintain Notification List																		
b	Perform Notification																		
SHARED RESOURCE MANAGEMENT																			
DMS/HAR Common Processes																			
a	Maintain Acceptable Word Dictionary																		
b	Maintain Unacceptable Word Dictionary																		
c	Perform Responsibility Reminder																		
d	Respond to Responsibility Reminder Alert																		
DMS Processes																			
a	Maintain DMS Message Library						R		CRUD										
b	DMS – Add a Message						R		R										
c	DMS – Remove a Message						R	R											
d	DMS – Arbitrate Message Queue							CRUD											
e	DMS – Evaluate Queue						R	RU											
f	DMS – Send a Message							U											
g	DMS – Blank a Sign																		
h	DMS - Reset						R	R											
i	DMS – Restore Message							R											
j	DMS- Override Queue						R	RU											
HAR Processes																			
a	Maintain HAR Message Library																		
b	HAR – Add a Message																		
c	HAR – Remove a Message																		
d	HAR – Arbitrate Message Queue																		
e	HAR – Evaluate Queue																		
f	HAR – Broadcast a Message																		

Figure 6-10. Process/Entity Matrix, Part 7/20

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Process	Functional Rights Group	Geographic Responsibility	HAR	HAR Message Arbitration Queue	HAR Message Library	HAR Stored Message Text	HAR Voice Message	Historical Data	Incident Interchange	Incident Log	Incident Log Text	Link	Location Navigation Info	Log	Message Rules	Notification Data	Notification List	NWS Alert File
d Log Incident Log									CU	CR	C							
e View Historical vs. Current								R										
f Log Congestion Log																		
g Log Recurring Congestion Log																		
h Log Special Event Log																		
i Log Weather Advisory Log																		
j Log Weather Sensor Log																		
k Log Safety Message Log																		
l View Log														R				
m Close Log														C				
Location Navigation																		
a Maintain Location Navigation Data													CRUD					
b Activate Location Navigator													R					
Queues																		
a Calculate Queue Length																		
Notification																		
a Maintain Notification List																	CRUD	
b Perform Notification																		R
SHARED RESOURCE MANAGEMENT																		
DMS/HAR Common Processes																		
a Maintain Acceptable Word Dictionary																		
b Maintain Unacceptable Word Dictionary																		
c Perform Responsibility Reminder														R				
d Respond to Responsibility Reminder Alert														CR				
DMS Processes																		
a Maintain DMS Message Library																		
b DMS – Add a Message																		
c DMS – Remove a Message																		
d DMS – Arbitrate Message Queue														C				
e DMS – Evaluate Queue																		
f DMS – Send a Message														C				
g DMS – Blank a Sign																		
h DMS - Reset														C				
i DMS – Restore Message																		
j DMS- Override Queue														C				
HAR Processes																		
a Maintain HAR Message Library					CRUD													
b HAR – Add a Message			R		R													
c HAR – Remove a Message			R	R														
d HAR – Arbitrate Message Queue				CRUD										C				
e HAR – Evaluate Queue			R	RU														
f HAR – Broadcast a Message				U										C				

Figure 6-11. Process/Entity Matrix, Part 8/20

	Operations Log	Operators Notepad	Organization	Pavement/Weather Sensor Data	Plan	Plan Item	Presets	Queue Data	Recurring Congestion Log	Recurring Congestion Log Text	Response Plan	Role	Safety Message Log	Safety Message Log Text	Scheduler Data	Scheduler Item	Sensor Data	SHAZAM
d Log Incident Log																		
e View Historical vs. Current																		
f Log Congestion Log																		
g Log Recurring Congestion Log									CR	C								
h Log Special Event Log																		
i Log Weather Advisory Log																		
j Log Weather Sensor Log																		
k Log Safety Message Log													CR	C				
l View Log																		
m Close Log		U																
Location Navigation																		
a Maintain Location Navigation Data	C																	
b Activate Location Navigator																		
Queues																		
a Calculate Queue Length	C							C										
Notification																		
a Maintain Notification List	C																	
b Perform Notification	C																	
SHARED RESOURCE MANAGEMENT																		
DMS/HAR Common Processes																		
a Maintain Acceptable Word Dictionary	C																	
b Maintain Unacceptable Word Dictionary	C																	
c Perform Responsibility Reminder																		
d Respond to Responsibility Reminder Alert	C																	
DMS Processes																		
a Maintain DMS Message Library	C				RD										RD			
b DMS – Add a Message																		
c DMS – Remove a Message																		
d DMS – Arbitrate Message Queue	C																	
e DMS – Evaluate Queue																		
f DMS – Send a Message	C																	
g DMS – Blank a Sign	C																	
h DMS - Reset	C																	
i DMS – Restore Message																		
j DMS- Override Queue	C																	
HAR Processes																		
a Maintain HAR Message Library	C				RD										RD			R
b HAR – Add a Message																		
c HAR – Remove a Message																		
d HAR – Arbitrate Message Queue	C																	
e HAR – Evaluate Queue																		
f HAR – Broadcast a Message	C																	

Figure 6-12. Process/Entity Matrix, Part 9/20

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		Signal	Smoothed Data	Special Event Log	Special Event Log Text	System Parameters	Tour	Unacceptable Word Dictionary	User	User Preferences	Users Center	Vehicle Data	Wall Monitor Assignment	Wall Monitor Configuration	Weather Advisory Log	Weather Advisory Log Text	Weather File	Weather Sensor Log	Weather Sensor Log Text	Weather Station
d	Log Incident Log																			
e	View Historical vs. Current		R																	
f	Log Congestion Log																			
g	Log Recurring Congestion Log																			
h	Log Special Event Log			CR	C															
i	Log Weather Advisory Log														CR	C				
j	Log Weather Sensor Log																	CR	C	
k	Log Safety Message Log																			
l	View Log																			
m	Close Log																			
Location Navigation																				
a	Maintain Location Navigation Data																			
b	Activate Location Navigator																			
Queues																				
a	Calculate Queue Length		R																	
Notification																				
a	Maintain Notification List																			
b	Perform Notification																			
SHARED RESOURCE MANAGEMENT																				
DMS/HAR Common Processes																				
a	Maintain Acceptable Word Dictionary																			
b	Maintain Unacceptable Word Dictionary							CRUD												
c	Perform Responsibility Reminder								R											
d	Respond to Responsibility Reminder Alert																			
DMS Processes																				
a	Maintain DMS Message Library								R											
b	DMS – Add a Message																			
c	DMS – Remove a Message																			
d	DMS – Arbitrate Message Queue																			
e	DMS – Evaluate Queue																			
f	DMS – Send a Message																			
g	DMS – Blank a Sign																			
h	DMS - Reset																			
i	DMS – Restore Message																			
j	DMS- Override Queue																			
HAR Processes																				
a	Maintain HAR Message Library								R											
b	HAR – Add a Message								R											
c	HAR – Remove a Message																			
d	HAR – Arbitrate Message Queue																			
e	HAR – Evaluate Queue																			
f	HAR – Broadcast a Message																			

Figure 6-13. Process/Entity Matrix, Part 10/20

			Acceptable Word Dictionary	Action Log	Action Log Text	Address Book	Alert Data	Archive	AVCM	AVL	Camera State Data	Center	Center Notepad	Chart Map Data	Communication Log	Communication Log Text	Component Configuration	Congestion Log	Congestion Log Text	County Snow Emergency Data
	g	HAR – Broadcast Default Message																		
	h	HAR – Set Shazam On/Off																		
	i	HAR – Update Default Message	R																	
	j	HAR – Send Maintenance Command																		
	k	HAR – Restore Message																		
	l	HAR - Override Queue																		
AVCM																				
	a	Maintain Wall Monitor Configuration																		
	b	Control Wall Monitor Assignment							R											
	c	Maintain CCTV Presets							R											
	d	Refresh Default AVCM Presets																		
	e	Maintain Tours							R											
	f	Activate Tour																		
	g	Control Camera									CRU									
Detectors																				
	a	Handle Polled Detector Data					C													
	b	Handle Detector Rules																	C	
	c	Generate Congestion Response					C											CR		
	d	Respond to Congestion Alert					R											CR		
	e	Generate Incident Response					C													
	f	Respond to Incident Alert					R													
	g	Activate Response Plan																	R	
Equipment																				
	a	Maintain Equipment Inventory																		
	b	Maintain Equipment Status										R								
	c	Alert For Delinquent Equipment Status					C					R								
	d	Respond to Delinquent Equipment Status Alert					CR													
Signals																				
	a	Handle Signal Polling Data					C													
	b	Respond to Exceeded Signal Threshold Alert					CR													
	c	Download Signal Data						C												
AVL																				
	a	Handle AVL Polling Results					C			R										
	b	Perform AVL Function Processing																		
	c	Process AVL In/Out of Service Message													CR					
	d	Process AVL Mayday Message					C													
	e	Process AVL Arrival On-Scene Message					C													
	f	Process AVL Assist Disabled Vehicle Message					C													
	g	Process AVL Assist Disabled CHART Vehicle Message					C													
	h	Process AVL Available Message																		
	i	Respond to AVL Alerts																		
	j	Respond to Mayday Alert from AVL					CR													
	k	Respond to Arrival On-Scene Alert from AVL		R			CR													

Figure 6-14. Process/Entity Matrix, Part 11/20

			Country Snow Emergency Map Data	Detector	Device Configuration	Disabled Log	Disabled Log Text	DMS	DMS Message Arbitration Queue	DMS Message Library	DMS Stored Message	EORS Map Data	EORS Permit Information	Equipment Inventory	Equipment Status	Failure Log	FITM Plan	Functional Responsibility and Alert Types	Functional Responsibility Group	Functional Right
	g	HAR – Broadcast Default Message																		
	h	HAR – Set Shazam On/Off								R										
	i	HAR – Update Default Message																		
	j	HAR – Send Maintenance Command																		
	k	HAR – Restore Message																		
	l	HAR - Override Queue																		
AVCM																				
	a	Maintain Wall Monitor Configuration			R															
	b	Control Wall Monitor Assignment																		
	c	Maintain CCTV Presets																		
	d	Refresh Default AVCM Presets																		
	e	Maintain Tours																		
	f	Activate Tour																		
	g	Control Camera																		
Detectors																				
	a	Handle Polled Detector Data														C				
	b	Handle Detector Rules																		
	c	Generate Congestion Response		U	R															
	d	Respond to Congestion Alert		RU																
	e	Generate Incident Response		U	R															
	f	Respond to Incident Alert		RU	R															
	g	Activate Response Plan																		
Equipment																				
	a	Maintain Equipment Inventory												CRUD						
	b	Maintain Equipment Status													CRUD					
	c	Alert For Delinquent Equipment Status																		
	d	Respond to Delinquent Equipment Status Alert																		
Signals																				
	a	Handle Signal Polling Data														C				
	b	Respond to Exceeded Signal Threshold Alert																		
	c	Download Signal Data			R											C				
AVL																				
	a	Handle AVL Polling Results														C				
	b	Perform AVL Function Processing																		
	c	Process AVL In/Out of Service Message																		
	d	Process AVL Mayday Message																		
	e	Process AVL Arrival On-Scene Message																		
	f	Process AVL Assist Disabled Vehicle Message				R														
	g	Process AVL Assist Disabled CHART Vehicle Message				R														
	h	Process AVL Available Message				R														
	i	Respond to AVL Alerts																		
	j	Respond to Mayday Alert from AVL																		
	k	Respond to Arrival On-Scene Alert from AVL				R														

Figure 6-15. Process/Entity Matrix, Part 12/20

		Functional Rights Group	Geographic Responsibility	HAR	HAR Message Arbitration Queue	HAR Message Library	HAR Stored Message Text	HAR Voice Message	Historical Data	Incident Interchange	Incident Log	Incident Log Text	Link	Location Navigation Info	Log	Message Rules	Notification Data	Notification List	NWS Alert File
g	HAR – Broadcast Default Message																		
h	HAR – Set Shazam On/Off																		
i	HAR – Update Default Message			R		R													
j	HAR – Send Maintenance Command			R	R										C				
k	HAR – Restore Message				R	R													
l	HAR - Override Queue			R	RU										C				
AVCM																			
a	Maintain Wall Monitor Configuration																		
b	Control Wall Monitor Assignment																		
c	Maintain CCTV Presets																		
d	Refresh Default AVCM Presets																		
e	Maintain Tours																		
f	Activate Tour																		
g	Control Camera																		
Detectors																			
a	Handle Polled Detector Data								CRU										
b	Handle Detector Rules								R					C					
c	Generate Congestion Response															R		R	
d	Respond to Congestion Alert																		
e	Generate Incident Response										CR					R		R	
f	Respond to Incident Alert										CR								
g	Activate Response Plan										R								
Equipment																			
a	Maintain Equipment Inventory																		
b	Maintain Equipment Status																		
c	Alert For Delinquent Equipment Status																		
d	Respond to Delinquent Equipment Status Alert																		
Signals																			
a	Handle Signal Polling Data																		
b	Respond to Exceeded Signal Threshold Alert																		
c	Download Signal Data																		
AVL																			
a	Handle AVL Polling Results																		
b	Perform AVL Function Processing																		
c	Process AVL In/Out of Service Message																		
d	Process AVL Mayday Message										C								
e	Process AVL Arrival On-Scene Message										R								
f	Process AVL Assist Disabled Vehicle Message																		
g	Process AVL Assist Disabled CHART Vehicle Message																		
h	Process AVL Available Message																		
i	Respond to AVL Alerts																		
j	Respond to Mayday Alert from AVL																		
k	Respond to Arrival On-Scene Alert from AVL										R								

Figure 6-16. Process/Entity Matrix, Part 13/20

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			Operations Log	Operators Notepad	Organization	Pavement/Weather Sensor Data	Plan	Plan Item	Presets	Queue Data	Recurring Congestion Log	Recurring Congestion Log Text	Response Plan	Role	Safety Message Log	Safety Message Log Text	Scheduler Data	Scheduler Item	Sensor Data	SHAZAM
	g	HAR – Broadcast Default Message	C																	
	h	HAR – Set Shazam On/Off	C																	
	i	HAR – Update Default Message	C																	
	j	HAR – Send Maintenance Command	C																	
	k	HAR – Restore Message																		
	l	HAR - Override Queue	C																	
AVCM																				
	a	Maintain Wall Monitor Configuration	C																	
	b	Control Wall Monitor Assignment	C																	
	c	Maintain CCTV Presets	C						CRUD											
	d	Refresh Default AVCM Presets	C						R											
	e	Maintain Tours	C																	
	f	Activate Tour	C																	
	g	Control Camera	C																	
Detectors																				
	a	Handle Polled Detector Data				R														
	b	Handle Detector Rules	C			R														
	c	Generate Congestion Response	C										C							
	d	Respond to Congestion Alert	C										R							
	e	Generate Incident Response	C																	
	f	Respond to Incident Alert	C																	
	g	Activate Response Plan	C										R							
Equipment																				
	a	Maintain Equipment Inventory	C																	
	b	Maintain Equipment Status	C																	
	c	Alert For Delinquent Equipment Status																		
	d	Respond to Delinquent Equipment Status Alert																		
Signals																				
	a	Handle Signal Polling Data	C																	
	b	Respond to Exceeded Signal Threshold Alert																		
	c	Download Signal Data	C																	
AVL																				
	a	Handle AVL Polling Results																		
	b	Perform AVL Function Processing	C																	
	c	Process AVL In/Out of Service Message																		
	d	Process AVL Mayday Message																		
	e	Process AVL Arrival On-Scene Message																		
	f	Process AVL Assist Disabled Vehicle Message																		
	g	Process AVL Assist Disabled CHART Vehicle Message																		
	h	Process AVL Available Message																		
	i	Respond to AVL Alerts																		
	j	Respond to Mayday Alert from AVL																		
	k	Respond to Arrival On-Scene Alert from AVL																		

Figure 6-17. Process/Entity Matrix, Part 14/20

Process	Signal	Smoothed Data	Special Event Log	Special Event Log Text	System Parameters	Tour	Unacceptable Word Dictionary	User	User Preferences	Users Center	Vehicle Data	Wall Monitor Assignment	Wall Monitor Config	Weather Advisory Log	Weather Advisory Log Text	Weather File	Weather Sensor Log	Weather Sensor Log Text	Weather Station
g HAR – Broadcast Default Message																			
h HAR – Set Shazam On/Off																			
i HAR – Update Default Message							R												
j HAR – Send Maintenance Command																			
k HAR – Restore Message																			
l HAR - Override Queue																			
AVCM																			
a Maintain Wall Monitor Configuration													CRUD						
b Control Wall Monitor Assignment												RU	R						
c Maintain CCTV Presets																			
d Refresh Default AVCM Presets					R														
e Maintain Tours						CRUD													
f Activate Tour						R						U	R						
g Control Camera																			
Detectors																			
a Handle Polled Detector Data		CR			R														
b Handle Detector Rules					R														
c Generate Congestion Response																			
d Respond to Congestion Alert																			
e Generate Incident Response																			
f Respond to Incident Alert																			
g Activate Response Plan																	R		
Equipment																			
a Maintain Equipment Inventory																			
b Maintain Equipment Status																			
c Alert For Delinquent Equipment Status					R														
d Respond to Delinquent Equipment Status Alert																			
Signals																			
a Handle Signal Polling Data					R														
b Respond to Exceeded Signal Threshold Alert																			
c Download Signal Data					R														
AVL																			
a Handle AVL Polling Results																			
b Perform AVL Function Processing											R								
c Process AVL In/Out of Service Message											C								
d Process AVL Mayday Message											C								
e Process AVL Arrival On-Scene Message											C								
f Process AVL Assist Disabled Vehicle Message											C								
g Process AVL Assist Disabled CHART Vehicle Message											C								
h Process AVL Available Message											C								
i Respond to AVL Alerts																			
j Respond to Mayday Alert from AVL																			
k Respond to Arrival On-Scene Alert from AVL																			

Figure 6-18. Process/Entity Matrix, Part 15/20

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			Acceptable Word Dictionary	Action Log	Action Log Text	Address Book	Alert Data	Archive	AVCM	AVL	Camera State Data	Center	Center Notepad	Chart Map Data	Communication Log	Communication Log Text	Component Configuration	Congestion Log	Congestion Log Text	County Snow Emergency Data
l		Respond to Disabled Vehicle Alert from AVL					CR													
ALERTS																			
	a	Send Manual Alert					C					R								
	b	Send Alert					C					R								
	c	Escalate Alert					R													
PLANS																			
	a	Maintain Plans																		
	b	Activate Plan																		
	c	Deactivate Plan																		
SCHEDULED EVENTS																			
	a	Maintain Scheduled Events																		
	b	Process Scheduled Events Start																		
	c	Process Scheduled Events End																		
EORS INTERFACE																			
Construction																			
	a	Download EORS Permits																		
	b	Activate EORS Icon On Map																		
	c	Activate EOR Permit																R		
Snow Emergency																			
	a	Maintain Snow Emergency Declaration																		C
Phone Book																			
	a	Access Phone Book																		
WEATHER SUPPORT																			
National Weather Service																			
	a	View National Weather Service Data																		
	b	Process Weather Alerts From The NWS					C													
	c	Respond to National Weather Service Alert					CR													
	d	Fax Weather Report																		
SCAN																			
	a	Handle Weather Sensor Data					C													
	b	Generate Weather Sensor Response					C													
	c	Respond to Weather Sensor Alert					R													
ARCHIVING AND REPORTS																			
Archiving																			
	a	Archive Update - Add																		
	b	Archive Update - Update Log Data																		
	c	Real Time System Update - Delete																		
Reports																			
	a	Operational Reports																		
	b	Reports from Archive																		

Figure 6-19. Process/Entity Matrix, Part 16/20

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			County Snow Emergency Map Data	Detector	Device Configuration	Disabled Log	Disabled Log Text	DMS	DMS Message Arbitration Queue	DMS Message Library	DMS Stored Message	EORS Map Data	EORS Permit Information	Equipment Inventory	Equipment Status	Failure Log	FITM Plan	Functional Responsibility and Alert Types	Functional Responsibility Group	Functional Right
	l	Respond to Disabled Vehicle Alert from AVL																		
ALERTS																				
	a	Send Manual Alert																R		
	b	Send Alert																R		
	c	Escalate Alert																R		
PLANS																				
	a	Maintain Plans																		
	b	Activate Plan																		
	c	Deactivate Plan																		
SCHEDULED EVENTS																				
	a	Maintain Scheduled Events																		
	b	Process Scheduled Events Start																		
	c	Process Scheduled Events End																		
EORS INTERFACE																				
Construction																				
	a	Download EORS Permits											C							
	b	Activate EORS Icon On Map										C								
	c	Activate EOR Permit											CR							
Snow Emergency																				
	a	Maintain Snow Emergency Declaration	C																	
Phone Book																				
	a	Access Phone Book																		
WEATHER SUPPORT																				
National Weather Service																				
	a	View National Weather Service Data																		
	b	Process Weather Alerts From The NWS																		
	c	Respond to National Weather Service Alert																		
	d	Fax Weather Report																		
SCAN																				
	a	Handle Weather Sensor Data														C				
	b	Generate Weather Sensor Response			R															
	c	Respond to Weather Sensor Alert																		
ARCHIVING AND REPORTS																				
Archiving																				
	a	Archive Update - Add																		
	b	Archive Update - Update Log Data																		
	c	Real Time System Update - Delete																		
Reports																				
	a	Operational Reports																		
	b	Reports from Archive																		

Figure 6-20. Process/Entity Matrix, Part 17/20

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			Functional Rights Group	Geographic Responsibility	HAR	HAR Message Arbitration Queue	HAR Message Library	HAR Stored Message Text	HAR Voice Message	Historical Data	Incident Interchange	Incident Log	Incident Log Text	Link	Location Navigation Info	Log	Message Rules	Notification Data	Notification List	NWS Alert File
	I	Respond to Disabled Vehicle Alert from AVL																		
ALERTS																				
	a	Send Manual Alert																		
	b	Send Alert																		
	c	Escalate Alert		R																
PLANS																				
	a	Maintain Plans																		
	b	Activate Plan														CR				
	c	Deactivate Plan														R				
SCHEDULED EVENTS																				
	a	Maintain Scheduled Events																		
	b	Process Scheduled Events Start																		
	c	Process Scheduled Events End														R				
EORS INTERFACE																				
Construction																				
	a	Download EORS Permits																		
	b	Activate EORS Icon On Map																		
	c	Activate EOR Permit										R								
Snow Emergency																				
	a	Maintain Snow Emergency Declaration																		
Phone Book																				
	a	Access Phone Book																		
WEATHER SUPPORT																				
National Weather Service																				
	a	View National Weather Service Data																		
	b	Process Weather Alerts From The NWS																		R
	c	Respond to National Weather Service Alert																		
	d	Fax Weather Report																		
SCAN																				
	a	Handle Weather Sensor Data																		
	b	Generate Weather Sensor Response																R	R	
	c	Respond to Weather Sensor Alert																		
ARCHIVING AND REPORTS																				
Archiving																				
	a	Archive Update - Add																		
	b	Archive Update - Update Log Data																		
	c	Real Time System Update - Delete																		
Reports																				
	a	Operational Reports																		
	b	Reports from Archive																		

Figure 6-21. Process/Entity Matrix, Part 18/20

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		Operations Log	Operators Notepad	Organization	Pavement/Weather Sensor Data	Plan	Plan Item	Presets	Queue Data	Recurring Congestion Log	Recurring Congestion Log Text	Response Plan	Role	Safety Message Log	Safety Message Log Text	Scheduler Data	Scheduler Item	Sensor Data	SHAZAM
l	Respond to Disabled Vehicle Alert from AVL																		
ALERTS																			
a	Send Manual Alert	C																	
b	Send Alert	C																	
c	Escalate Alert	C																	
PLANS																			
a	Maintain Plans	C				CRUD										D			
b	Activate Plan	C				R													
c	Deactivate Plan	C				R													
SCHEDULED EVENTS																			
a	Maintain Scheduled Events	C														CRUD			
b	Process Scheduled Events Start	C														R			
c	Process Scheduled Events End	C														D			
EORS INTERFACE																			
Construction																			
a	Download EORS Permits															R			
b	Activate EORS Icon On Map																		
c	Activate EOR Permit	C																	
Snow Emergency																			
a	Maintain Snow Emergency Declaration	C																	
Phone Book																			
a	Access Phone Book																		
WEATHER SUPPORT																			
National Weather Service																			
a	View National Weather Service Data																		
b	Process Weather Alerts From The NWS	C																	
c	Respond to National Weather Service Alert																		
d	Fax Weather Report	C																	
SCAN																			
a	Handle Weather Sensor Data				C														
b	Generate Weather Sensor Response	C			C	R						C						C	
c	Respond to Weather Sensor Alert	C			RU							R						RU	
ARCHIVING AND REPORTS																			
Archiving																			
a	Archive Update - Add																		
b	Archive Update - Update Log Data																		
c	Real Time System Update - Delete																		
Reports																			
a	Operational Reports																		
b	Reports from Archive																		

Figure 6-22. Process/Entity Matrix, Part 19/20

		Signal	Smoothed Data	Special Event Log	Special Event Log Text	System Parameters	Tour	Unacceptable Word Dictionary	User	User Preferences	Users Center	Vehicle Data	Wall Monitor Assignment	Wall Monitor Configuration	Weather Advisory Log	Weather Advisory Log Text	Weather File	Weather Sensor Log	Weather Sensor Log Text	Weather Station
l	Respond to Disabled Vehicle Alert from AVL																			
ALERTS																				
a	Send Manual Alert																			
b	Send Alert								R											
c	Escalate Alert																			
PLANS																				
a	Maintain Plans																			
b	Activate Plan																			
c	Deactivate Plan																			
SCHEDULED EVENTS																				
a	Maintain Scheduled Events																			
b	Process Scheduled Events Start																			
c	Process Scheduled Events End																			
EORS INTERFACE																				
Construction																				
a	Download EORS Permits					R														
b	Activate EORS Icon On Map					R														
c	Activate EOR Permit			R																
Snow Emergency																				
a	Maintain Snow Emergency Declaration																			
Phone Book																				
a	Access Phone Book																			
WEATHER SUPPORT																				
National Weather Service																				
a	View National Weather Service Data																			
b	Process Weather Alerts From The NWS					R														
c	Respond to National Weather Service Alert																			
d	Fax Weather Report					R											R			
SCAN																				
a	Handle Weather Sensor Data																			R
b	Generate Weather Sensor Response																	CR		
c	Respond to Weather Sensor Alert																	CR		
ARCHIVING AND REPORTS																				
Archiving																				
a	Archive Update - Add																			
b	Archive Update - Update Log Data																			
c	Real Time System Update - Delete																			
Reports																				
a	Operational Reports																			
b	Reports from Archive																			

Figure 6-23. Process/Entity Matrix, Part 20/20

7 Technology Model View

This section presents model views of the Technology domain of change as derived from CHART II visioning workshops and analysis of the technological architecture required to support the proposed processes. The Direction Model provides the principles, constraints and assumptions that guide the design of the technological architecture. The Diagnostic Model describes existing components that will be considered for use. The Conceptual Model presents a high-level view of the planned architecture for the CHART II system. The Performance Model provides a summary of the performance requirements for the system.

7.1 Technology Direction Model

This model shows what application principles, constraints, and assumptions impact the project.

7.1.1 Technology Principles, Constraints, and Assumptions

Numerous principles, constraints, and assumptions (PCAs) were derived for this particular model view. The table below shows how the BAA process scored in applying the identified PCAs. The scoring is defined as follows:

❶   Applied = The PCAs were observed and applied to one or more of the Domains of Change

❷   To Be Applied = The PCAs were not viewed as relevant to this phase of the project, but may be applied in later phases (*i.e.,* Design, Development, and Deployment)

❸   Not Applicable = The PCAs identified were replaced by different approaches used in process design

Principles	
❶	CHART II will use the statewide communications network to meet the bulk of its wide area network requirements
❶	Existing technical components will be incorporated (as deemed appropriate) to support future business requirements.
❶	The CHART II system will have the capability of being fully distributed.
❶	A RDBMS will be used to store and manage persistent data.
❶	The Common Object Request Broker Architecture (CORBA) will be used to manage and distribute objects between clients and servers.
Constraints and Standards	
❶	All components will be Y2K compliant.
❶	All appropriate components will be NTCIP compliant.

❶	The solution will be compatible with the Windows NT operating system.
Assumptions	
❶	The Network Management System will be in place in time to support CHART II.

7.1.2 Key Technical Performance Factors

Key technical performance factors are a high-level summary of factors presenting risks or challenges from a technical perspective.

- The system will support operations 24 hours a day, 7 days a week.

- Provide a highly available system through redundancy and geographic distribution.

- The state of the system (device status, current messages, etc) shall be maintained and shall persist through a system shutdown and startup cycle.

7.1.3 Technology Requirements Model

The Technology Requirements model documents the technical services, hardware, system software, and network communications needs of the system.

Enterprise-Wide Standard Technology Requirements

Category	Requirements
Hardware	The following are the estimated minimum requirements for CHART hardware. Actual hardware deployed will be based on the detailed hardware requirements and will take into account the current state of the industry (e.g. use of the latest processor chips). • Standard workstation hardware is 200Mz (or better) dual processor, 256MB memory, 9GB storage. • Standard server hardware is 200Mz (or better) quad processor, 512MB memory, 20GB RAID. • CHART-Lite hardware is 200Mz (or better) single processor, 128MB memory, 4GB storage.

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Category	Requirements

Software	• Operating system software is Windows NT 4.0 Service Pack 5.
	• Standard workstation software suite includes:
	  - Novell GroupWise email
	  - Microsoft Office
	  - Web browser (Netscape or Internet Explorer)
	• Standard server software suite includes:
	  - Oracle 8i

Communications	• Communications between servers and from servers to the field devices must be available 24 hours/day. • Failure of communications to a server or failure of a server will not affect the ability of other servers from communicating with field devices.

Technology Requirements Matrix

Technology Location	Node	Requirements
Statewide Operations Center (SOC)	Servers and workstations	• Supports all CHART applications. • Central site for CHART administration and configuration.
Emergency Operations Center (EOC)	Servers and workstations	• Ability to take over full range of CHART functions from SOC in an emergency.
Traffic Operations Centers (TOC)	Servers and workstations	• All SOC functions except CHART administration and configuration.
Authority Operations Center (AOC)	Workstations	• Map display and report generation.
Network Operations Center (NOC)	Workstations	• Map display and report generation.
Maryland State Police (MSP)	Workstations	• Map display and report generation.
Maintenance Shops	Workstations	• Map display and report generation.
CHART-Lite users	CHART-Lite Workstations	• Capability to perform any SOC function. Allowable functions controlled on a per user basis.

7.2 Technology Diagnostic Model

7.2.1 Technology Profile

The Technology Profile summarizes key information about current technology capabilities.

Hardware

Location	Technology Type	Vendor	Description
SOC	Server	Compaq	Proliant 5000
SOC	Workstation	Compaq	Deskpro 6000
SOC	Workstation	Compaq	Professional 5000
SOC	Workstation	Compaq	AP/400
TOC-4	Workstation	Compaq	Professional 5000
TOC-4	Workstation	Compaq	AP/400
TOC-3	Workstation	Compaq	Professional 5000
TOC-3	Workstation	Compaq	Deskpro 6000
AOC	Workstation	Compaq	Professional 5000
NOC	Workstation	Compaq	Professional 5000

Software

Location	Technology Type	Vendor	Description
SOC	Application	Silverlake	Paging software
SOC	Application	SSI	SCAN/WEB software for windows (Weather Pavement Sensors)
SOC	Productivity	Novell	GroupWise email

7.3 Conceptual Technology Model

7.3.1 Technology Concept Diagram

The diagram below shows the conceptual architecture of the future system illustrating the use of the CORBA ORB for process communication.
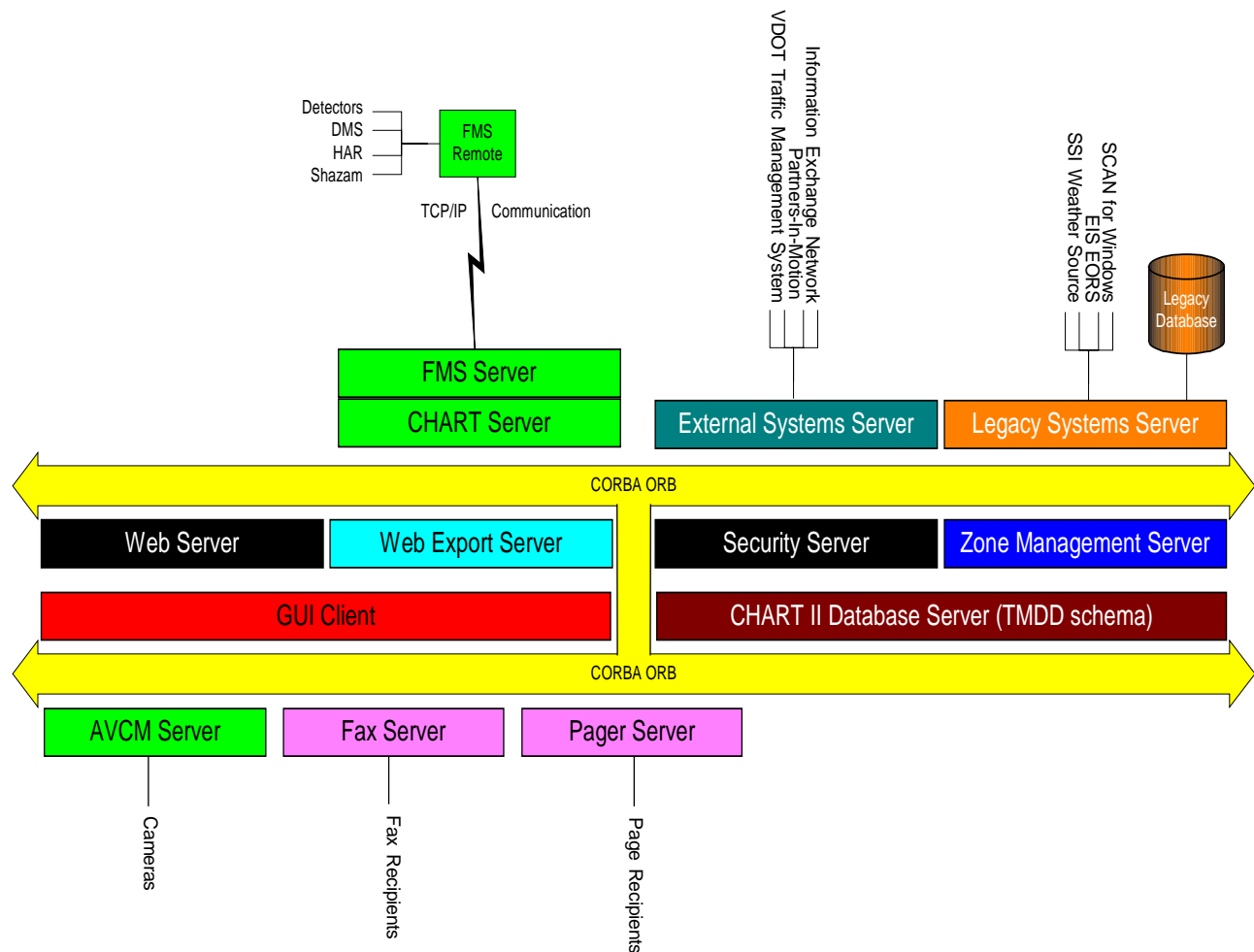

Figure 7-1. CHART II Conceptual Architecture

7.3.2 Network Concept Diagram

Below is a network concept diagram showing the future system network connectivity.


Figure 7-2. CHART II Network Concept Diagram

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7.4 Performance Engineering Model

7.4.1 System Performance

The tables presented below summarize the performance requirements that have been identified as being drivers in the design of the system. This includes response time requirements, transaction volume estimates, and storage requirements.

Response Time

Category	Response Time (seconds)	Source
Redraw/update screens	3	Requirement M-P1
Update message on a DMS	10	Goal

Transaction Volume

The transaction rates shown in the table below are aggregate rates for the entire system. The conceptual architecture does not limit the transaction volume that the system can handle. Higher transaction rates can be accommodated by adding additional hardware (and possibly network bandwidth) as needed.

Transaction	Aggregate System Rate	Source
Detector data	1.6 entry/sec	187 detectors (minimum) 1 entry/detector/2 min
Weather data	<1/min (summer) 2.2/min (winter)	44 weather stations 1 entry/detector/60 min (summer) 1 entry/detector/20 min (winter)
Operations Log	2.5/min	Derived

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Storage

Storage estimates presented in the table below are for the major data sources and account for the majority of the storage requirements.

Item	Size	Source
Devices characteristics	10,000 devices * 1868 bytes = 1.8MB	MDSHA CHART Software Functional Requirements Document
Operations Log	3,500 entries/day * 1439 bytes = 5MB/day	Derived
Event Log	20 entries/day * 14K bytes = 0.3MB/day	Derived
Detector data	134,640 entries/day * 30 bytes = 4MB/day	Derived
Weather data	1,056 entries/day * 30 bytes = 32KB/day (summer) 3168 entries/day * 30 bytes = 95KB/day (winter)	Derived

7.4.1 System Availability

The CHART system must support operations 24 hours per day year round. To achieve this the system architecture definition is guided by the following concepts:

- Redundancy
  - Redundant hardware at key locations guards against loss of service due to hardware failures.
  - Replication of key data guards against loss of service due to loss of data access.
- Fault Tolerance
  - Distributed architecture (with data replication) ensures that a failure at one location does not jeopardize continued operations from other locations.
  - Multi-path communications network (combined with the distributed architecture) minimizes the chance of an operational device becoming completely unreachable.
- Fault Identification
  - System monitoring and alerting provides timely notification of system problems to operations personnel so that corrective action can be taken promptly.

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Appendix A – List of Acronyms

The following acronyms appear throughout this document:

AOC   Authority Operations Center

AOR   Area of Responsibility

ATM   Asynchronous Transfer Mode

ATMS   Automated Transportation Management System

AVCM   ATM Video Control Module

AVL   Automatic Vehicle Locator

BAA   Business Area Architecture

CCTV   Closed-Circuit Television

CHART   Coordinated Highways Action Response Team

CORBA   Common Object Request Broker Architecture

COTS   Commercial Off-The-Shelf (usually a software package)

DBMS   Database Management System

DMS   Dynamic Message Sign

EORS   Emergency Operations Reporting System

ERU   Emergency Traffic Patrol

ETP   Emergency Response Unit

FITM   Freeway Incident Management Traffic Management

FMS   Field Management Station

GIS   Geographic Information System

GUI   Graphical User Interface

HAR   Highway Advisory Radio

HOT   Highway Operations Technician

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IEN	I-95 Corridor Coalition Information Exchange Network
ITS	Intelligent Transportation System
MDOT	Maryland Department of Transportation
MdTA	Maryland Transportation Authority
MSP	Maryland State Police
MTA	Mass Transit Administration
NIA	National ITS Architecture
NWS	National Weather Service
PIM	Partners in Motion
R1B1	Release 1, Build 1 of the CHART II System
SHA	State Highway Administration
SOC	Statewide Operations Center
TMDD	Traffic Management Data Dictionary
TOC	Traffic Operations Center
VDOT	Virginia Department of Transportation
VMS	Variable Message Sign
XAD	Accelerated Application Development